NAVAL POSTGRADUATE SCHOOL

Monterey, California

A COMPUTER SIMULATION CASE

FOR THE AUDITING CLASSROOM,

by

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November 1973

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ABSTRACT

During fiscal year 1972, the writer developed an auditing case which is currently used in the course MN 4151 (Internal Control and Auditing) at the Naval Postgraduate School. This case involves complex auditing and internal control problems related to manufacturing inventories and it is based upon a computer simulation model. The case has been well received by NPS students and appears to be a very effective teaching tool.

A teaching approach for using this simulation case is described in an article entitled "A Computer Simulation Approach for Teaching the Evaluation of Internal Control." This article is scheduled for publication by the American Accounting Association early in 1974 in the Association's forthcoming book, tentatively entitled Accounting Education.

This report contains copies of all of the material which is necessary to implement the teaching approach described in the article mentioned above. The purpose of this report is to make the simulation case available to auditing instructors at universities other than the Naval Postgraduate School.

Prepared by:

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INTRODUCTION

This report contains the materials referred to as the "package of materials" in the article entitled "A Computer Simulation Approach for Teaching the Evaluation of Internal Control." At the time of this writing, this article is scheduled to appear in the American Accounting Association's forthcoming book on accounting education.

For quick reference, the "package of materials" referred to in the article mentioned above is located in this report as follows:

1. Computer simulation program listing----------Appendix B
2. Flow charts of the computer simulation program--Figure 5 and Appendix A
3. Systems Description----------pages 6 - 25
4. List of necessary audit tests of compliance-----Figure 6
5. Audit memorandum----------pages 67 - 69
6. Four probability distributions----------Appendices E, F, G and H.

In addition to the materials listed above, a detailed narrative description of the simulation model is presented in this report at pages 29 through 66. This description should provide the instructor the "inside knowledge" he will need to fulfill his role-playing parts in the teaching approach.

DESCRIPTION OF THE OPERATIONS AND THE INVENTORY ACCOUNTING AND CONTROL SYSTEM OF THE HYPOTHETICAL FIRM

DESCRIPTION OF THE OPERATIONS OF THE HYPOTHETICAL FIRM

The firm is assumed to be engaged in the machining and sales of alloy-cast-iron pipe fittings. The firm produces a full line of over two thousand pipe fittings in various sizes and designs. However, this case is confined to the inventory accounting and controls related to four products from the firm's total line. The four pipe fittings are assumed to constitute one distinct product line of the firm. This line is sold, in large lots, primarily to building contractors, the petroleum and chemical industry, and industrial equipment manufacturers. The four products selected are assumed to constitute

a material percentage of total annual sales volume. They are further assumed to be representative of the total product line of the firm for purposes of testing the inventory accounting system. A detailed cost build up of the four products is presented as Exhibit 1.

DESCRIPTION OF THE RAW MATERIALS ACCOUNTING AND CONTROL SYSTEM

Raw Materials Policies

All raw materials are carried on the company's records at standard cost. At year end, the raw materials account is adjusted to the lower of standard cost or market.

A perpetual inventory of raw material quantities on hand and on order is maintained by the production control department. This record is updated daily for raw material orders requisitioned, orders received from vendors and materials requisitioned into production.

A physical inventory is taken each year on September 30. The perpetual and financial records are adjusted to the physical inventory. The company relies upon financial records to provide an accurate account of inventory transactions between September 30 and the December 31 year end.

Raw Materials Accounting and Control Procedures

Production control clerks review the raw material perpetual stock control records and production schedule each day. They prepare purchase order requisitions for raw materials. The size of an individual order depends upon many factors but rarely exceeds three hundred units. Company policy is to maintain approximately a two month's supply of raw material on hand at all times. This policy safeguards against raw material shortage and supply problems.

EXHIBIT 1

UNIT PRODUCT COST BUILDUP

	Product Number 1	Product Number 2	Product Number 3	Product Number 4
Direct Material				
Type of material	R.M. 1	R.M. 2	R.M. 3	R.M. 4
Units required	1	1	1	1
Spoilage, scrap, shrinkage	0	0	0	0
Standard cost of material	$13.5000	$16.7000	$ 6.5000	$ 8.000
Total Direct Material/Unit	$13.5000	$16.7000	$ 6.5000	$ 8.000
Direct Labor				
Department I				
Standard dir. lbr. hrs./unit	.06 hr.	.09 hr.	.04 hr.	.06 hr.
Standard dir. lbr. rate	$6.20/hr.	$6.20/hr.	$6.20/hr.	$6.20/hr.
Total standard dir. lbr. charge	$ .3720	$ .5580	$ .2480	$ .3720
Department II				
Standard dir. lbr. hrs./unit	.04 hr.	.06 hr.	.04 hr.	.07 hr.
Standard dir. lbr. rate	$5.60/hr.	$5.60/hr.	$5.60/hr.	$5.60/hr.
Total standard dir. lbr. charge	$ .2240	$ .3360	$ .2240	$ .3920
Total Direct Labor/Unit	$ .5960	$ .8940	$ .4720	$ .7640
Burden				
Department I				
Standard dir. lbr. hrs/unit	.06 hr.	.09 hr.	.04 hr.	.06 hr.
Standard burden rate	$12.85/hr.	$12.85/hr.	$11.40/hr.	$11.40/hr.
Total standard burden charge	$ .7710	$ 1.1565	$ .4560	$ .6840
Department II				
Standard dir. lbr. hrs/unit	.04 hr.	.06 hr.	.04 hr.	.07 hr.
Standard burden rate	$51.55/hr.	$51.55/hr.	$44.05/hr.	$44.05/hr.
Total standard burden charge	$ 2.0620	$ 3.0930	$ 1.7620	$ 3.0835
Total Burden/Unit	$ 2.8330	$ 4.2495	$ 2.2180	$ 3.7675
Total Unit Standard Cost	$ 16.9290	$ 21.8435	$ 9.1900	$ 12.5315

Purchase order requisitions are prepared on a standardized two-copy form. The original copy is forwarded to the purchasing department and the second copy is filed in production control in a temporary-hold file. (See Figure 1)

The purchasing agents prepare the purchase orders from the purchase requisitions. A separate purchase order is prepared for each raw material order. The agent obtains standard material prices from the standard cost file maintained in the cost accounting department. The purchasing agent extends the purchase order and forwards it to a clerk who distributes the individual copies of the form and prepares the vendor copy for mailing. (See Figure 1)

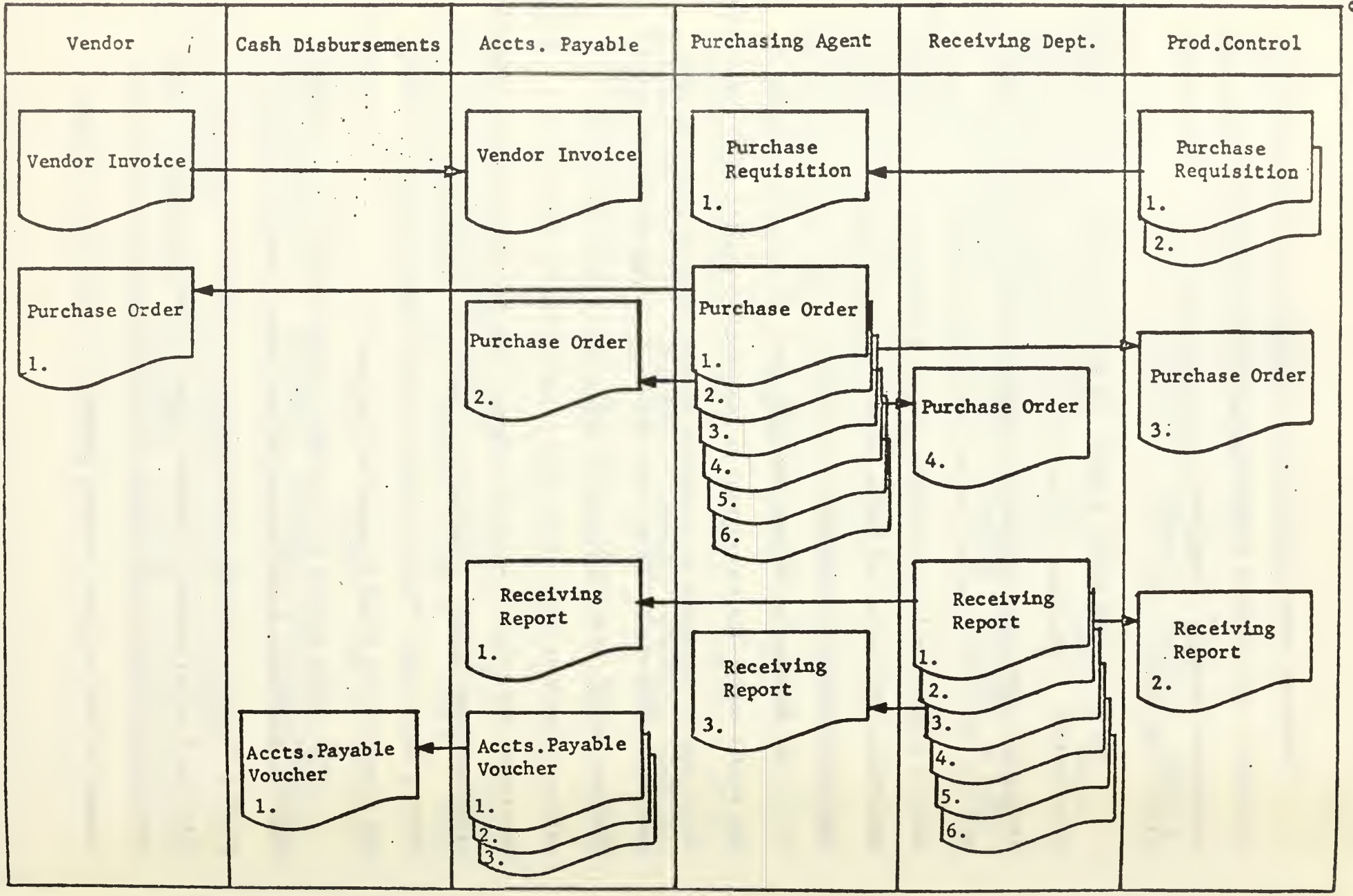
The purchase order is a six-copy form. The original copy is the vendor copy. The second copy is the accounts payable copy. The third copy is forwarded to production control where it serves as an open order file and is matched with the purchase requisition to confirm the order. The fourth copy of the purchase order is the receiving department copy. This copy is maintained by the receiving department and compared with the shipment when the order arrives. The fifth and sixth copies of the purchase order are filed in the purchasing department. The fifth copy is filed alphabetically by vendor. The sixth copy is filed in numerical sequence.

The orders shipped by the vendor foundries often vary slightly from the quantities stated on the purchase order. Vendor foundries produce the alloy castings especially for the company in accordance with rigid specifications. Vendors often experience considerable variation in production yields and have thus obtained permission from the company to ship all good castings produced. If quantities produced

FIGURE 1

DOCUMENT FLOW

RAW MATERIAL PURCHASING AND RECEIVING



by the foundries vary by a material amount from quantities ordered by the company, however, the vendor foundry is expected to contact the company for special permission to ship. If shipment is permitted, the purchasing agent contacts the receiving department and the receiving copy of the purchase order is changed to reflect the special circumstances.

Receiving department personnel inspect and weigh-count all incoming raw material shipments. All local vendors make delivery via their own trucks. The exact quantity received for each shipment is determined by the receiving department personnel and the vendor company's truck driver at the time of delivery. The procedure has been agreed upon and followed by the company and its vendors for many years. All orders are shipped to the company in large wooden boxes supplied by the vendor. These boxes accompany the castings throughout the manufacturing process up to the point of transfer of completed castings to finished goods inventory. After castings are transferred to finished goods the boxes are returned to raw materials stores and are then picked up by the vendors' truck drivers from time to time.

Receiving department personnel prepare a six-copy, pre-numbered, receiving form for each order received. (See Figure 1) Receiving forms are prepared chronologically in numberical sequence. The following data are entered upon the six-copy receiving form:

1. Name of vendor
2. Purchase order reference number
3. Quantity ordered
4. Quantity received
5. Description of item
6. Part number of item
7. Date

8. Signature of checker
9. Signature of truck driver
10. Date signed by truck driver

The original number one copy of the receiving form is the accounts payable copy. The second copy is forwarded to production control for posting to the perpetual stock control records. The third copy of the receiving form is forwarded to the purchasing agent to confirm receipt of the order. The fourth copy of the receiving form is placed in a clear-plastic envelope and attached to the box containing the order. The fifth and sixth copy of the receiving form are filed in the receiving department. The fifth copy is filed alphabetically by vendor. The sixth copy is filed in numerical sequence.

After receiving and inspection are completed the raw material orders are moved to the raw materials storage area where they are stored until use. Orders are stored in their wooden shipping boxes in the raw materials storage area.

Accounts payable clerks match vendors' invoices with receiving reports, vendors' shippers, and the purchase order and voucher the invoice for payment. Standard costs noted on the purchase order are used in the vouchering operation. Inventory is charged at standard cost extended by the quantity actually received. Purchase price variances are recorded in an appropriate price variance account. Problems arising from a disagreement between the quantity of material received and quantity billed are charged or credited to detailed unsettled claims accounts at actual price. Claims are cleared by the purchasing department.

Production orders are issued to the foreman of the department

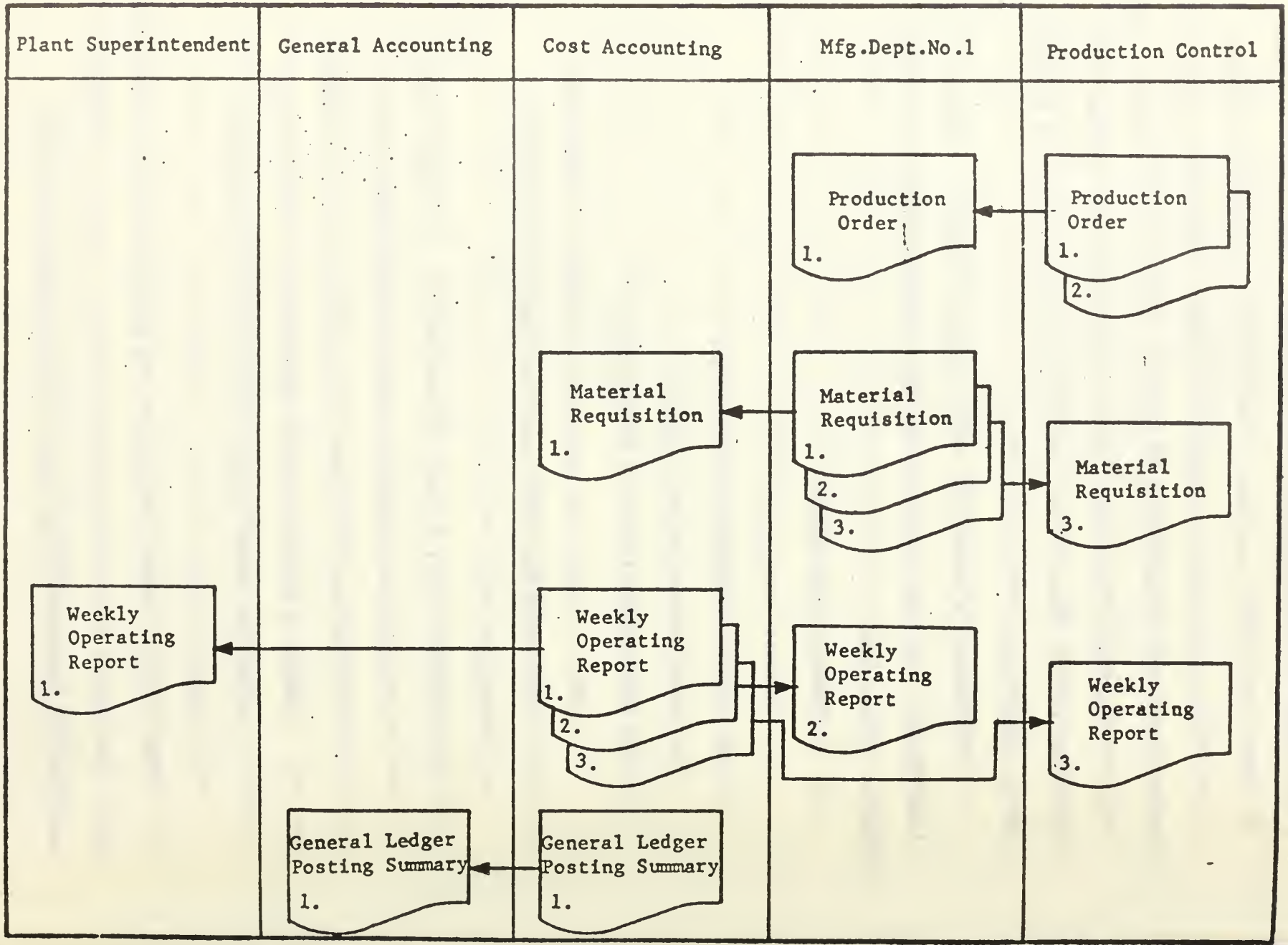
performing the first operation on the product. Orders are scheduled by production control one month in advance and released to foreman a week before production is scheduled to begin. Individual production orders vary from approximately 50 units to 250 units in size but average about one hundred fifty units. Orders larger than two hundred fifty units are rarely scheduled as they produce material handling problems on the shop floor.

The company's production order is a pre-numbered, two-copy form (See Figure 2) All copies of the form provide spaces for the following information:

1. Product part number
2. Product description
3. Suggested number to be produced
4. Date production is to start
5. Date production is to be completed
6. Copy one only; four spaces are provided for the machine operator's employee number and the good castings produced.
7. Copy one only; a space is provided for the weigh-counter to record the quantity of good castings transferred to finished goods. A space is also provided for the weigh-counter's signature which specifies that the previous production count agrees closely with the weigh-count check.

The original number one copy of the production order is the shop copy. The second copy of the production order is filed in numerical sequence, by production order number, in the production control

FIGURE 2
DOCUMENT FLOW
PRODUCTION ORDERS AND MATERIAL REQISITIONS



department. The production order number and suggested production quantity is cross referenced to the perpetual stock control records.

The foreman of the department involved in the first operation on the product distributes the production orders to available operators in his department. At the time of distribution, the foreman and machine operator decide, in the light of the current shop-load situation, and the suggested production control quantity, the exact quantity of raw castings to requisition and machine. When the requisitioned materials arrive, the operator attaches the production order to the box which contains the raw castings. This box is used to move the castings throughout the shop up to the time the castings are transferred into the finished goods inventory. Each time a machine operator completes an order, he places his employee number and the quantity of good castings produced on the appropriate space of the production order form. Production orders are not split, but are maintained in tact throughout the production process.

Foremen of departments other than those involved in the first operation of a product are made aware of the status of the shop and incoming orders by a status report prepared by the production control department every other day.

The company does not maintain tight security over the raw materials storage area. There is no stores clerk and several raw materials handlers have access to the area at all times. Company rules specify that raw material storage is to be considered "off limits" for machine operators at all times. It is doubtful that the policy is very effective as no security fence or other protection devices have been installed.

A machine operator can requisition raw materials by preparing

a material requisition obtained from his department foreman. (See Figure 2) The raw material requisition is a three-copy, pre-numbered form. It contains spaces for the following information:

1. Type of material requisitioned
2. Quantity requisitioned
3. Quantity of good castings produced
4. Production order number
5. Date
6. Signature of employee
7. Signature of foreman
8. Signature of material handler

The operator completes the three-copy requisition for all of the above information except the quantity of good castings produced, signature of the foreman, and the signature of the material handler. After completing the form with the above information, the operator obtains the approval of the foreman. Upon obtaining approval, he presents the third copy of the requisition to a raw material handler who locates the material and moves it to the proper machine location. The machine operator checks the material located by the material handler for propriety. If agreement is reached between the material handler and the machine operator, the material handler signs all three copies of the material requisition and forwards the third copy to production control. Production control updates the perpetual stock control records for the raw material requisition and files the third copy of the requisition by production order.

If the machine operator completes the production order by the end of the day, he completes the original and second copy of the form

by filling in the actual quantity of good castings produced. He then places both copies of the form in a hopper in the foreman's office. If the machine operator does not complete the production order on the same day the material is requisitioned, he holds the first and second copy of the requisition form until the job is completed. When the production order is complete he fills in the actual production count and disposes of the form in the same manner previously described.

The foreman reviews the material requisition placed in a hopper by the machine operators. His review includes a reasonableness scan of all information included on the form and a verification of the recorded production count. The foreman signifies that he has completed his review by initialing the second copy of the form. He then files the number two copy in numerical sequence, by material requisition number.

The original copies of the material requisitions are collected each morning by a cost accounting clerk. Cost accounting personnel apply predetermined material cost and quantity standards to the requisitions using the standard cost file. Each day the cost accounting personnel batch the costed requisitions by department and file them until the end of the weekly reporting period. At the end of the reporting period the weekly production report and raw material journal entry are prepared from the batches of requisitions processed during the week. The raw materials account is credited at standard cost for the actual quantity of materials requisitioned.

DESCRIPTION OF THE WORK-IN-PROCESS ACCOUNTING AND CONTROL SYSTEM

Work-In-Process Policies

All work in process is carried on the company's records at standard cost. A perpetual inventory of the approximate number of

units-in-process is maintained by the production control department.

Company policy is to cease the production of new orders for one or two days prior to the September 30 physical inventory. This policy permits the producing departments to complete all units in process up to the point of transfer into finished goods. All completed units not physically transferred into finished goods at year end are physically counted and transferred by journal entry to the finished goods inventory account. Perpetual stock control records are adjusted to the physical count.

Work-In-Process Accounting and Control Procedures

All raw materials enter the production process at the beginning of the first productive operation. Accounting and control of raw materials is discussed in the raw materials section.

Direct labor and burden are applied to work-in-process inventory at standard cost for good units produced. Physical direct labor hour standards have been established by time-study and necessarily differ according to the product produced. Direct labor rates vary among the producing departments. A cost build up of the four products is presented as Exhibit 1.

Indirect labor is charged to overhead along with other manufacturing expenses. Overhead is applied to inventory on the basis of predetermined rates per standard direct labor hour charged to inventory. Burden rates vary depending upon the producing department and the product produced.

Machine operator's labor is handled as direct labor and charged directly to the respective departments. Labor efficiency and rate variances are calculated by operating department and summarized on the weekly

operating report.

Attendance timekeeping is supervised by the cost accounting department. All factory employees, except supervisory employees, are issued an employee number and are required to clock in and out of the plant. A cost accounting clerk supervises the time clock procedure and delivers the clock cards to the payroll department each morning after the clock-in procedure is completed.

Plant production timekeeping is also supervised by the cost accounting department. Direct labor is reported on job time tickets, which are maintained and prepared by the direct labor employees. Machine operators are the only employees reporting on a direct labor basis. The company's job time ticket is a three-copy form. (See Figure 3) The form is designed to include spaces for filling in the following information:

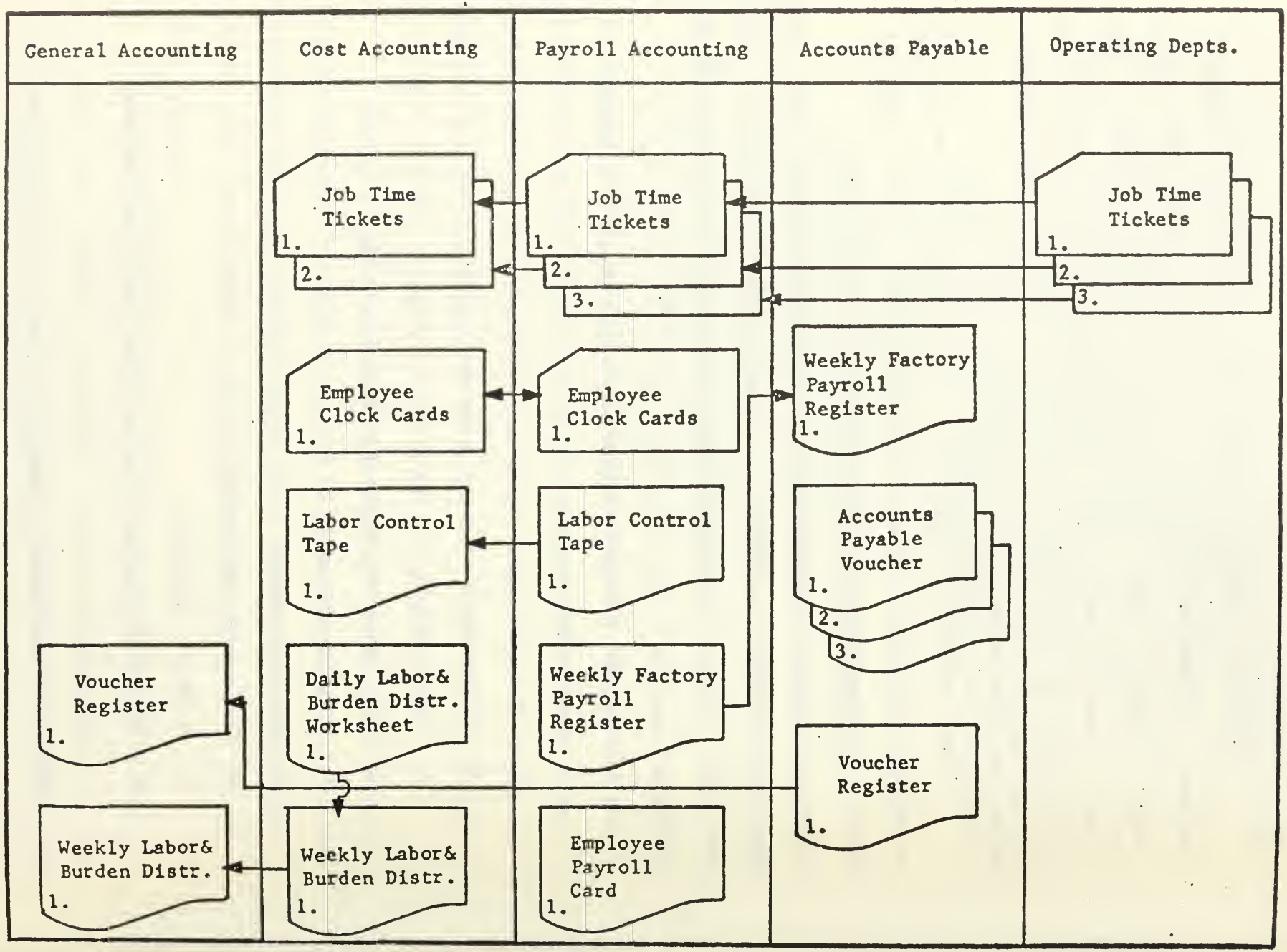
1. Employee number (the employee number includes a department number prefix)
2. Job ticket number
3. Time production on the order was started
4. Time production on the order was stopped
5. Total hours worked on the production order
6. Product part number
7. Operation number
8. Good pieces completed
9. Foreman's signature
10. Appropriate spaces for payroll and cost accounting computations

The job ticket number is always the same as the production

FIGURE 3

DOCUMENT FLOW

PLANT JOB TIMEKEEPING SYSTEM



order number. Multiple production orders cannot be reported on the same job time ticket. Some production orders, however, require more than one day to complete. In such cases multiple job tickets are prepared for the production order. When a production order is begun during a given day and not completed by quitting time, a job time ticket is prepared at the end of the day. An "I" is placed after the job ticket number to signify that the production order is incomplete. Subsequent job time tickets applying to this production order are distinguished by placing a dash after the job ticket number. The dash is followed by a digit which indicates the number of the job time tickets which have been filed on that particular production order. The last ticket of a series applying to a given production order is distinguished by a circle on the job ticket number.

Machine operators prepare a job time ticket for each production order they complete or for production completed on an order they are working on at the close of the day. The machine operator completes the form for the information included in points one, through eight of the above job time ticket description. The operator places the completed form in a hopper located on the foreman's desk. The foreman reviews the job time ticket for propriety and reviews the production count for reasonableness. The foreman signs the job ticket if he finds no exceptions. During the morning of the next business day, a clerk from cost accounting collects the authorized forms from the various department formen and delivers them to the payroll department for processing.

The payroll department sorts the time tickets by employee and compares the total time charged by each employee to the total time noted

on the employee's clock card. Idle time is isolated. Then incentive earnings are computed and noted on each copy of the three copy job time ticket. The payroll clerk separates the third copy of the job time ticket form from the original and second copy. The top two copies are forwarded to cost accounting for further processing. The payroll department batches the third copy of the job time ticket by employee number. Total days earnings and idle time are noted on each batch of job tickets for future use in preparing the factory payroll. Control tapes of total earnings and idle time by department are prepared and used to reconcile to the daily labor distribution worksheet prepared by the cost accounting department.

Cost accounting clerks cost the job tickets for direct labor and burden by referencing the standard cost file.

Standards and extended charges and variances are noted on both the number one and number two copy of the job time ticket. The daily labor and burden distribution worksheet is updated after all the previous days job time tickets have been costed. Labor figures appearing on the distribution are reconciled to the daily labor control tape, prepared by the payroll department. At the end of the weekly reporting period, a weekly labor and burden distribution is prepared from the daily worksheet. The weekly distribution is reconciled to payroll department controls and forwarded to general accounting for posting to the financial records.

The original number one copy of the job ticket is sorted by department and filed by day. The number two copy is filed by job number. All number two copies applying to incomplete production orders are filed by job ticket number in a temporary file.

DESCRIPTION OF FINISHED GOODS TRANSFERS ACCOUNTING AND CONTROL SYSTEM; POLICIES AND PROCEDURES

After all operations have been completed on a production order, material handlers move the order to the weigh station located near the finished goods storage area. All production orders must be weigh-counted before transfer to finished goods. The weigh-count serves as a control over production reporting.

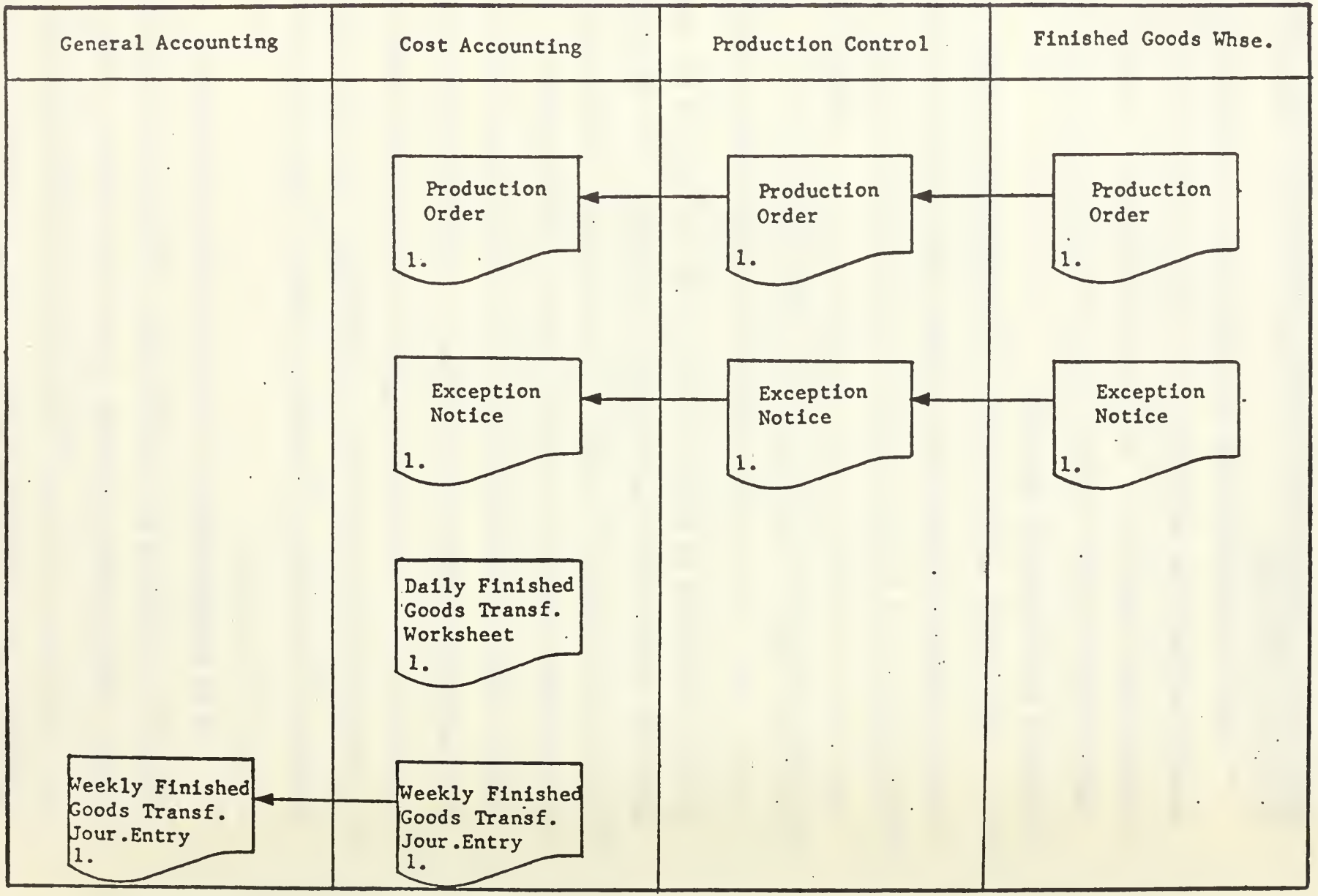
The material handler conducting the weigh-count operation verifies the production count on the production order attached to the wooden box containing the finished castings. If the weigh-count differs materially from the production count, the material handler conducting the weigh-count prepares an exception notice which he attaches to the production order. The production order and the attached exception notice are then transferred to production control and the order is set aside until the actual count is ascertained. (See Figure 4) If no material exception arises as a result of the weigh-count, the material handler signs the production report, dates it, and forwards it to production control. Production control updates the perpetual stock control records by subtracting the production order transferred from the work-in-process file, at the original suggested quantity, and by adding the actual quantity transferred to the finished goods stock control record. All entries to the unit stock control records are cross-referenced to production order numbers.

If an exception notice accompanies the production order, the exception is investigated and resolved before the perpetual records are updated. Employees from production control act as mediators between production foremen, operators, and the employee operating the weigh-station in resolving exception notices. The perpetual file is updated

FIGURE 4

DOCUMENT FLOW

FINISHED GOODS TRANSFERS



for resolved correction notices in the same manner described for approved finished goods transfers.

After the perpetual records have been updated, production control stamps the production order and correction notices "transferred" and forwards them to the cost accounting department. Cost accounting personnel cost the transfer and prepare a daily transfer worksheet which recaps the day's transfers and exception notices processed. At the end of the weekly reporting period the worksheet is used to prepare the weekly finished goods inventory transfer journal entry. This entry is forwarded to general accounting for posting to the financial records.

RESULTS OF THE AUDITOR'S INTERNAL CONTROL REVIEW

It is assumed that the auditor's preliminary internal control review has been conducted and that audit tests of transactions have been performed on certain areas of the accounting system.[1] It is further assumed that the following strengths and weaknesses were noted during the internal control review of the raw materials, work-in-process, and transfers from work-in-process to finished goods areas.

STRONG POINTS NOTED DURING THE INTERNAL CONTROL REVIEW

1. General accounting controls and procedures are well designed. Audit tests of transactions in the general accounting area have been conducted. The system was found to be functioning as described. No weaknesses or irregularities were discovered in general accounting

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[1]The term internal control review refers to the auditor's preliminary assessment of the internal controls in effect. The internal control review is considered to include such auditing procedures as observation and inquiry but no testing of transactions. It is assumed that the results of the internal control review are summarized in memorandum form.

procedures related to inventory.

2. Cost accounting procedures and controls related to the preparation of general accounting inventory posting summaries, daily and weekly labor and burden distributions and attendance and shop timekeeping activities are well designed. Audit tests have been employed on these cost accounting processes and no irregularities were discovered.

3. Procedures and controls related to the maintenance of the perpetual stock control records were reviewed and tested. Controls are adequate and no exceptions were uncovered by the tests employed.

WEAKNESSES NOTED DURING THE INTERNAL CONTROL REVIEW

1. Discussions with plant personnel indicate that receiving and inspection personnel do not physically check all incoming shipments in accordance with company procedure. Receiving personnel are said to accept the vendor's count without question in many cases.

2. The company policy prohibiting machine operators from entering the raw materials stores area is not being followed. Three machine operators were sighted in the raw materials stores area during the internal control review. This situation represents a material weakness in control over production reporting. This weakness could permit employees to requisition excessive materials to cover spoilage and elevated production reporting. Under the present situation it is possible for machine operators to return excessive materials, used to conceal elevated production reporting, to stores without being noticed.

3. The standard cost file was scanned for general housekeeping propriety during the internal control review of cost accounting controls and procedures. The internal control review indicated that the file is in poor condition. For example, the reviewer found many standard cost

cards had been filed under incorrect product line categories. This situation could cause erroneous costing as similar products with similar physical characteristics and nearly identical part numbers carry different standard costs, depending on their product line.

The reviewer also noticed that cost clerks have revised standard cost cards by lining out the original typed standard figure and filling in the new standard with colored ink. In many instances several revisions have been made, and it is difficult to determine the proper authorized standard cost.

Current company procedures do not require that costing applications be double checked by a second employee. There is a very heavy costing workload. In general, the internal control review indicates that there is a material weakness in control over costing operations.

5. Current company procedures require the purchasing agent to consult the standard cost file in the preparation of raw material purchase orders. Company procedures should be changed to restrict access to the standard cost file solely to cost accounting personnel.

6. The internal control review tended to indicate that operating foremen do not maintain proper control over raw material requisitions. During the internal control review, stacks of blank material requisitions, all pre-signed by the respective foremen, were noted on the desks of two departmental foremen. Employees were observed taking forms from the stack at their discretion. The foremen involved could not produce number two file copies of the material requisitions for review. Current company procedure stipulates that foremen should review the quantity of material requisitioned for reasonableness in relation to the suggested production order size. This procedure is designed to allow the shop foremen and

machine operators some flexibility in determining the exact production order size in light of current shop floor status. The procedure also serves as a control over raw materials requisitioned and production reported. These factors contribute materially to weak control over production reporting.

7. The internal control review tended to indicate that foremen do not check production counts noted on the job time ticket in accordance with prescribed company procedure. This situation represents an additional threat to control over production reporting.

8. Observations and inquiries conducted during the internal control review indicated that the material handler, who conducts the weigh-count operation on stock transferred to finished goods, does not perform his duties in accordance with prescribed company procedures. Pressure from machine operators is said to have caused him to become somewhat lax in his duties.

DESCRIPTION OF THE COMPUTER SIMULATION MODEL OF THE INVENTORY ACCOUNTING AND CONTROL SYSTEM

INTRODUCTION TO THE SIMULATION MODEL OF THE SYSTEM

The simulation model is designed to represent the activity of the inventory accounting and control system as described over a nine-month time period. The model design incorporates the internal control weaknesses as assumed and described in the preceding section of this paper. These weaknesses are incorporated in such a manner that they cause the model to generate and to process various accounting documents erroneously. This, in turn, causes the computer simulation model to generate unreliable ending inventory balances.

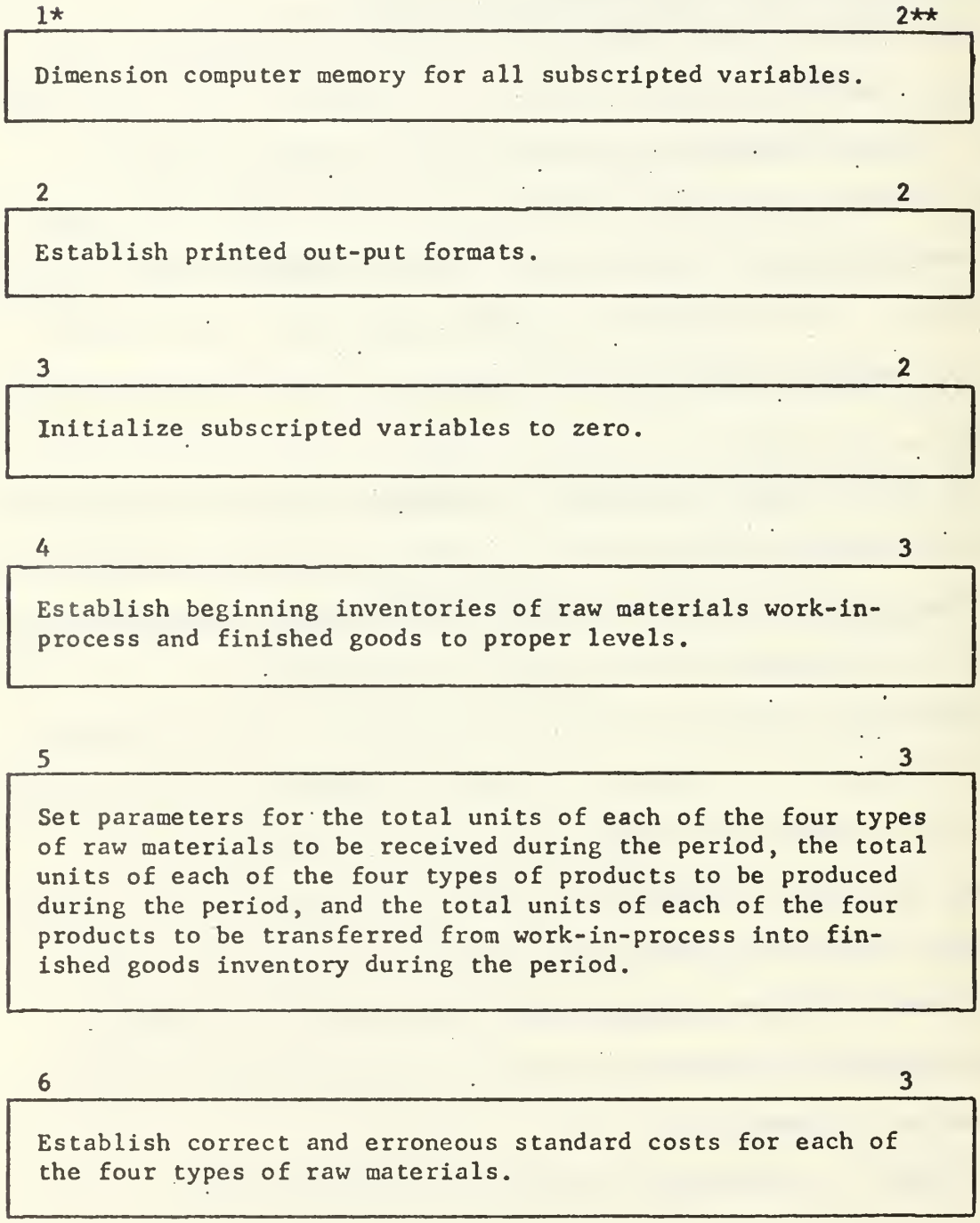
The computer simulation program is designed to print out summaries of all of that detailed information which is needed to perform audit tests of the transactions processed by the system simulation model. Detailed descriptions of this information are given later in this paper.

A brief description of the operational characteristics of the model is given in Figure 5. Figure 5 is cross-referenced to a more detailed procedural flow chart of the model which appears in Appendix A. The procedural flow chart in Appendix A is further cross-referenced to a copy of the computer simulation program which also appears in Appendix B. The variable names, operating characteristics and parameters of the computer simulation program are described in detail in a variable name dictionary also presented in Appendix C.

As Figure 5 indicates, the scope of the model has been

FIGURE 5

OPERATIONAL FLOW CHART OF THE SYSTEM SIMULATION MODEL



* Description reference number for this flow chart.

** Cross reference to description reference number of detailed procedural flow chart of Appendix A.

FIGURE 5 Con't.

7 3

Establish correct and erroneous material, labor, burden, and total unit standard costs for each of the four types of products to be produced.

8 3

Initialize work-in-process material, labor, and burden accumulators to zero.

9 3

Set parameters establishing the mean and standard deviation of shipment sizes for each of the four types of raw materials to be received. Shipment sizes are assumed to be normally distributed.

10 4,5

Generate the number of units shipped for each individual raw material shipment from a normal distribution in accordance with the shipment size parameters previously established. For each type of raw material, continue to generate individual shipments until the accumulated total number shipped, of each of the four types of raw materials, equals the respective parameter limiting the total units to be received during the period.

11 6,7,8

Simulate the preparation of the receiving form by the receiving and inspection department by processing each shipment previously generated. Cause errors to occur in the recording of the quantity of goods received on the receiving form.

FIGURE 5 Con't.

12	9
Print the SUMMARY OF SHIPMENTS RECEIVED AND RECEIVING REPORTS PROCESSED IN TERMS OF UNITS.	

13	10,11,12,13
Simulate the procedures employed by the purchasing agent in applying raw material price standards to the purchase order. Cost each receiving report previously generated and cause errors to occur in the application of raw material price standards. Maintain a CONTROL record over the errors generated by the receiving and inspection operation and the costing operation by applying correct standard material costs to original shipments previously generated.	

14	12,13
Extend the quantity received, recorded on each receiving report, by the standard material cost previously generated. Update the REPORTED raw material inventory by adding the accumulated amount of all extended receiving forms processed to the beginning raw material inventory. Extend all shipments received by the appropriate correct standard material cost. Update the CONTROL raw material inventory by adding the accumulated amount of all extended receiving forms processed to the beginning raw material inventory CONTROL record.	

15	14
Print the LISTING OF SHIPMENTS RECEIVED AND RECEIVING REPORTS PROCESSED; PRICED AND EXTENDED AT STANDARD COST.	

16	15-20
Generate the number of units actually produced for each production order processed during the period. The size of production orders is assumed to follow a normal distribution with mean of 150 units and at standard deviation of 35 units. For each of the four types of products, production orders are generated until the accumulated quantity produced equals the previously established parameter limiting the total units to be produced during the period.	

FIGURE 5 Con't.

17 17

Simulate the preparation of job time tickets applying to each production order. Reprocess each production order quantity, previously generated, and generate production counts for Department I and Department II applicable to the production order. The simulation process is designed to overstate some production counts generated. These errors occur in accordance with pre-defined probability distributions. The production counts generated are assumed to be those noted on the job time tickets prepared by Department I and Department II.

18 18,19,23,24 25,30,31,32

Simulate the procedures employed by the cost accounting department in applying labor and burden standards to the job time tickets. Direct labor and burden standards are applied to each job time ticket. Errors occur in the application of standards in accordance with pre-defined probability distributions. Maintain a CONTROL record over the errors generated by the production count operation and the costing operation by applying appropriate correct labor and burden standards to the production orders previously generated.

19 26,33

Update the REPORTED work-in-process inventory for labor and burden charges resulting from the processing of job time tickets generated for Departments I and II. This is accomplished by extending the reported production count on each job time ticket by the labor and burden standards applied and accumulating the extended labor and burden charges for all time tickets processed. Update the CONTROL work-in-process inventory in a similar manner by extending the actual production quantities generated for each production order by correct standard costs.

20 27,34

Print the PRODUCTION ORDER SUMMARY FOR THE PERIOD for Departments I and II.

FIGURE 5 Con't.

21 35,36,37

Generate actual material usage for each production order manufactured during the period. Actual material usage is assumed to equal target for the actual quantity produced for each production order. No scrap or spoilage is assumed to occur.

22 38

Generate the quantity of raw materials requisitioned for each production order manufactured during the period. This quantity is always the same as the production count recorded by Department I. It is assumed that excessive raw materials are requisitioned and used to cover overstated production reporting. Excessive materials not used in production are assumed to be returned to raw material stores by the machine operators. These returns are unauthorized.

23 39,40

Simulate the procedures employed by the cost accounting department in applying raw material standards to raw material requisitions. Errors occur in the application of standards to material requisitions in accordance with pre-defined probability distributions. Maintain a CONTROL record over the errors caused by faulty reporting of quantities of raw material used in production and the application or erroneous standard costs. Apply correct raw material standards to the actual raw material usage figures previously generated.

24 41,42

Update the REPORTED raw materials and work-in-process inventories by accumulating the extended quantity of raw materials requisitioned for each production order. This process assumes that machine operators in Department I always report production counts equal to the number of units of material they requisition for an order. Update the CONTROL raw materials and work-in-process inventories by accumulating the extended CONTROL quantity of materials used to produce each production order.

FIGURE 5 Con't.

25 43

Print the MATERIAL REQUISITION SUMMARY.

26 49,50,51,52,61,69

Simulate the weigh-count operations involved in transferring production orders from work-in-process inventory to finished goods. Process and transfer all production orders-in-process, for each of the four types of products, up to the point where the accumulated total units of each product actually transferred equals the limit established for the total units to be transferred during the period. The remaining units not transferred are assumed to be fully complete but not formally transferred. Erroneous reporting in the weigh-count operation is simulated by transferring all production orders, not containing a production miscount of more than 20 units, at the erroreous production count figures. All orders containing a production count error in excess of 20 units are adjusted to the correct count and then transferred.

27 55,56,63,64

Simulate the cost accounting procedures employed in applying standard costs to production orders transferred to finished goods. Errors occur in the application of standard costs to production orders transferred in accordance with pre-defined probability distributions. Errors also occur in adjusting for production count errors noted by the weigh-count operation. Work-in-process material, labor and burden accounts are adjusted as if the total production count error originated in Department I. Maintain a CONTROL record over the errors caused by faulty production reporting and cost accounting operations by applying the correct standard cost to the actual quantity of goods transferred for each production order.

FIGURE 5 Con't.

28	56,57,58,59,64 65,66,67,70,71
Update the REPORTED work-in-process and finished goods inventories by accumulating the unreliable extended value of the goods reported as transferred on each production order. Work-in-process inventory is credited for material labor, and burden and finished goods is charged with full standard cost. Adjustments are also made for production count errors noted by the weigh-count operation. Update the CONTROL work-in-process and finished goods inventories by accumulating the CONTROL extended value of the actual units transferred.	

29	60,68
Print the SUMMARY OF PRODUCTION ORDERS TRANSFERRED TO FINISHED GOODS.	

30	72
Print FINAL SUMMARY REPORT.	

restricted to activity related to the four products and their respective component raw materials previously selected for audit testing purposes. The total nine-months activity for these items is summarized in Exhibits 2, 3, and 5.

Most of the nine-month activity total figures presented in Exhibits 2, 3 and 5 have been treated as parameters of the system simulation model. How these figures serve as parameters of the model is best explained in the context of a specific example.

As is explained in detail in the subsequent section of this paper which deals with the model's operating characteristics, the model has been designed to generate, internally, individual raw material shipments. Each shipment generated contains a specified quantity of one of the four types of raw materials. For the case of each of the four types of raw material, the model is designed to continue the generation of individual shipments until the accumulated total quantity of units shipped generated equals the respective "units received during the period" figure given in Exhibit 2.

Many of the other figures which appear in Exhibits 2, 3 and 5 have also been treated as parameters of the model in similar manner. The specific figures which have been treated as parameters will be mentioned in the following sections of this paper.

MAJOR ASSUMPTIONS OF THE SIMULATION MODEL OF THE SYSTEM

As Figure 5 illustrates, the focus of the simulation model is the preparation and processing of individual raw material receiving forms, raw material requisition forms, job time tickets, and production orders. Accounting procedures and processes related to the preparation and processing of such documents as posting summaries, journal entries,

EXHIBIT 2

RAW MATERIALS INVENTORIES AND ACTIVITY FOR THE NINE MONTH PERIOD ENDED SEPT. 30;

IN TERMS OF UNITS AND AT STANDARD COST

	Raw Material Number 1	Raw Material Number 2	Raw Material Number 3	Raw Material Number 4
Raw Materials Inventories and Activity; in Terms of Units				
Units in beginning inventory	8,000	8,000	7,000	6,500
Units received during the period	40,000	34,000	34,000	32,000
Units to be accounted for	48,000	42,000	41,000	38,500
Units issued into production	33,600	33,000	33,000	28,900
Units in ending inventory	14,400	9,000	8,000	9,600
Raw Materials Inventories and Activity; at Standard Cost				
Raw Material unit price standard	$ 13.50	$ 16.70	$ 6.50	$ 8.00
Beginning Inventory	108,000	133,600	45,500	52,000
Raw Material received during the period	540,000	567,800	221,000	256,000
Raw Material to be accounted for	$ 648,000	$ 701,400	$ 266,500	$ 308,000
Raw Material issued into production	453,600	551,100	214,500	231,200
Ending inventory	$ 194,400	$ 150,300	$ 52,000	$ 76,800

EXHIBIT 3

WORK-IN-PROCESS INVENTORIES AND ACTIVITY FOR THE NINE MONTH PERIOD ENDED SEPT. 30;

IN TERMS OF UNITS AND AT FULL STANDARD COST

	Product Number 1	Product Number 2	Product Number 3	Product Number 4
Work-In-Process Inventories and Activity In Terms of Units				
Units in beginning inventory	0	0	0	0
Units placed into process during the period	33600	33000	33000	28900
Units to be accounted for	33600	33000	33000	28900
Units transferred to finished goods inventory during the period	30280	30964	29777	21719
Units in ending inventory	3320	2036	3223	7181

EXHIBIT 3 (Continued)

WORK-IN-PROCESS INVENTORIES AND ACTIVITY FOR THE NINE MONTH PERIOD ENDED SEPT. 30;

IN TERMS OF UNITS AND AT FULL STANDARD COST

	Product Number 1	Product Number 2	Product Number 3	Product Number 4	Total for All Four Products
Work-In-Process Inventories and Activity at Standard Cost					
Unit std. cost of product	$ 16.9290	$ 21.8435	$ 9.1900	$ 12.5315	
Beginning inventory	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00
Production charges to W.I.P. during the period	568,814.40	720,835.50	303,270.00	362,160.35	1,955,080.25
Total std. cost to be accounted for	$568,814.40	$720,835.50	$303,270.00	$362,160.35	$1,955,080.25
Total std. cost of units transferred to finished goods during the period	512,610.12	676,362.13	273,650.63	272,171.65	1,734,794.53
Ending inventory	$ 56,204.28	$ 44,473.37	$ 29,619.37	$ 89,988.70	$ 220,285.72

EXHIBIT 4

WORK-IN-PROCESS INVENTORIES AND ACTIVITY FOR THE NINE MONTH PERIOD ENDED SEPT. 30;

IN TERMS OF MATERIAL, LABOR AND BURDEN CONTENT

	Product Number 1	Product Number 2	Product Number 3	Product Number 4	Total for All Four Products
Beginning Inventory	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00
Direct material charged to W.I.P.	453,600.00	551,100.00	214,500.00	231,200.00	1,450,400.00
Direct labor charged to W.I.P.	20,025.60	29,502.00	15,576.00	22,079.60	87,183.20
Burden applied to W.I.P.	95,188.80	140,233.50	73,194.00	108,880.75	417,497.05
Total charges to W.I.P. for production during the period	$ 568,814.40	$ 720,835.50	$ 303,270.00	$ 362,160.35	$ 1,955,080.25
Direct material content of finished goods transferred	$ 408,780.00	$ 517,098.80	$ 193,550.50	$ 173,752.00	$ 1,293,181.30
Direct labor content of finished goods transferred	18,046.88	27,681.82	14,054.74	16,593.32	76,376.76
Burden content of finished goods transferred	85,783.24	131,581.52	66,045.39	81,826.33	365,236.48
Total std. cost of finished goods transferred	$ 512,610.12	$ 676,362.14	$ 273,650.63	$ 272,171.65	$ 1,734,794.54

EXHIBIT 4 (Continued)

WORK-IN-PROCESS INVENTORIES AND ACTIVITY FOR THE NINE MONTH PERIOD ENDED SEPT. 30;

IN TERMS OF MATERIAL, LABOR AND BURDEN CONTENT

	Product Number 1	Product Number 2	Product Number 3	Product Number 4	Total for All Four Products
Direct material content of ending inventory	$ 44,820.00	$ 34,001.20	$ 20,949.50	$ 57,448.00	$ 157,218.70
Direct labor content of ending inventory	1,978.72	1,820.18	1,521.26	5,486.28	10,806.44
Burden content of ending inventory	9,405.56	8,651.98	7,148.61	27,054.42	52,260.57
Total standard cost of ending inventory	$ 56,204.28	$ 44,473.36	$ 29,619.37	$ 89,988.70	$ 220,285.71

EXHIBIT 5

FINISHED GOODS INVENTORIES AND ACTIVITY FOR THE NINE MONTH PERIOD ENDED SEPT. 30;

IN TERMS OF UNITS AND AT FULL STANDARD COST

	Product Number 1	Product Number 2	Product Number 3	Product Number 4
Finished Goods Inventories and Activity in Terms of Units				
Units in beginning inventory	4,000	4,500	6,000	5,000
Units transferred into finished goods from work-in-process during the period	30,280	30,964	29,777	21,719
Units available for sale during the period	34,280	35,464	35,777	26,719
Units sold and shipped during the period	30,600	31,000	29,000	21,500
Units in ending inventory	3,680	4,464	6,777	5,219

EXHIBIT 5 (Continued)

FINISHED GOODS INVENTORIES AND ACTIVITY FOR THE NINE MONTH PERIOD ENDED SEPT. 30;

IN TERMS OF UNITS AND AT FULL STANDARD COST

Finished Goods Inventories and Activity at Standard Cost	Product Number 1	Product Number 2	Product Number 3	Product Number 4	Total for All Four Products
Unit standard cost of product	$ 16.9290	$ 21.8435	$ 9.1900	$ 12.5315	
Beginning inventory	$ 67,716.00	$ 98,295.75	$ 55,140.00	$ 62,657.50	$ 283,809.25
Standard cost of units transferred into finished goods from work-in-process during the period	512,610.12	676,362.13	$ 273,650.63	272,171.65	1,734,794.53
Standard cost of units available for sale during the period	$580,326.12	$ 774,657.88	$ 328,790.63	$ 334,829.15	$2,018,603.78
Standard cost of units sold during the period	518,027.40	677,148.50	266,510.00	269,427.25	1,731,113.15
Ending inventory	$ 62,298.72	$ 97,509.38	$ 62,280.63	$ 65,401.90	$ 287,490.63

recap worksheets, control tapes, and ledger accounts are not represented by the model. These documents are ignored as it is assumed that they are accurately prepared. This assumption is in agreement with the assumed results of the preliminary internal control review discussed in the preceding section of this paper.

Procedures and controls related to the sales and withdrawal of finished goods inventory are also assumed to present no threat to the reliability of the inventory balances generated by the system. Thus, all of the accounting processes related to the sales and withdrawal of finished goods inventory are assumed to operate in an error-free manner. This assumption eliminates the necessity of a detailed representation of the above accounting processes in the model. Instead, the model treats total withdrawals for the nine-month period as a parameter and makes one adjustment to finished goods available for sale for the entire period's sales. Total withdrawals from finished goods inventory for the nine-month period for each of the four products is shown in Exhibit 5. If the above assumption had not been made, it would have been necessary to include all of the detailed procedures related to the sales and withdrawal of finished goods inventory in the design of the model. These additional detailed procedures would have caused the resultant model descriptions to be unreasonably long.

The model is designed on the assumption that all productive activity during the period actually takes place at perfect predetermined standard levels and that no manufacturing cost accounting variances actually arise. This assumption is merely arbitrary and is not crucial to the purpose of this case.

Other assumptions of the model will be introduced in the context of the following sections which describe the operating characteristics of the model. This will be done for further clarification.

THE OPERATING CHARACTERISTICS OF THE SIMULATION MODEL

Most of the unreliable processes assumed to result from weaknesses in internal control, are represented in the model as stochastic (probabilistic) processes. These stochastic processes are designed either to cause the model to generate production reporting errors or to apply, erroneously, incorrect standard costs to various documents generated by the model. The computer simulation program is designed to maintain a dual accounting record of each transaction processed. One record is maintained of the data subjected to, or generated by, the unreliable stochastic processes. These data will be referred to as the "REPORTED" data. A second record is maintained as a control. The data included in the control record is always correctly processed. It never includes any error. These data will be referred to as the "CONTROL" data. Detailed descriptions of the stochastic processes incorporated in the model are included in the variable name dictionary which appears in Appendix C.

Raw Material Shipments and Units Produced for a Given Production Order

Raw material shipments and units produced for a given production order are treated as external inputs (exogenous variables) to the model. As Figure 5 indicates, the computer simulation program generates normally distributed individual shipments for all four raw materials. The program is designed to continue the generation of individual shipments until the accumulated total quantity shipped, for each raw material,

equals the pre-established total quantity to be received for the nine-month period. The total quantity to be received for the period for each raw material is treated as a parameter of the model and is shown in Exhibit 2.

The number of units produced for a given production order are also generated by the simulation program in a manner similar to that described for raw material shipments. The major difference is that units produced on a given production order are generated, one production order at a time, then further processed; whereas all shipments are generated before further processing begins. This fact is not clearly indicated by Figure 5 but it is shown in the procedural flow chart of the model which appears in Appendix A.

The quantity of raw materials included in each shipment and the number of units produced for a given production order are assumed to follow normal distributions with specified means and standard deviations. The means and standard deviations are treated as parameters of the model. The means and standard deviations of the various normal distributions incorporated in the model are presented in Exhibit 6.

The computer simulation program generates normally distributed random variates by using the Monte Carlo[2] technique. The computer program carries out the Monte Carlo process by generating a random variate from a standard normal distribution using the following direct approach:[3]

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[2]The Monte Carlo technique is a procedure for generating a sequence of random observations from a specified probability distribution, given a sequence of uniformly distributed random numbers. The uniformly distributed random numbers fall between the limits of zero and one. A more detailed explanation of the Monte Carlo method is presented in Van Court Hare, Jr., System Analysis: A Diagnostic Approach, (New York, New York: Harcourt, Brace & World, Inc., 1967), pp. 377-87.

[3]Thomas H. Naylor, Joseph L. Balintly, Donald S. Burdick, and Kong Chu, Computer Simulation Techniques, (New York: John Wiley & Sons, Inc., 1966), p. 95.

EXHIBIT 6

THE MEANS AND STANDARD DEVIATIONS OF THE NORMAL DISTRIBUTIONS USED FOR THE RAW MATERIAL SHIPMENT AND UNITS PRODUCED ON A PRODUCTION ORDER GENERATORS

	Mean	Standard Deviation
Raw Material Shipments:		
Raw Material Number 1	200	25
Raw Material Number 2	180	30
Raw Material Number 3	200	25
Raw Material Number 4	180	30
Units Produced on a Production Order:		
Product Number 1	150	35
Product Number 2	150	35
Product Number 3	150	35
Product Number 4	150	35

$$X1 = (-2 \times \log_e a)^{\frac{1}{2}} \times \text{cosine } (2 \times b)$$

Where:

X1 = a random variate from a standard normal distribution and, a and b = pseudo-random numbers between 0 and 1.

The computer program then converts the random variate (X1) from the standard normal form to the normal form with the desired mean and standard deviation by using the following formula:

$$X = (X1 \times \sigma) + u$$

Where:

X1 = a random variate from a standard normal distribution and, X = the desired random variate from the desired normal distribution and, σ = the specified standard deviation of the desired normal distribution, established as a parameter of the model and, u = the desired mean of the desired normal distribution established as a parameter of the model.

Receiving and Inspection Operations

The model is designed to simulate receiving and inspection operations by generating a receiving and inspection count for each raw material shipment created. Weaknesses in internal control over receiving and inspection operations are incorporated in the design of the model and result in the recording of unreliable receiving and inspection counts. The unreliable counting process is represented by stochastic processes designed into the model. The computer simulation program uses the Monte Carlo technique to determine whether or not a given shipment is to be erroneously recorded. The stochastic process is designed in such a manner that each shipment processed has a twenty-five per cent chance of being erroneously recorded on the receiving and inspection form. When the computer simulation program determines that an error is to occur on a

given shipment, it understates the receiving and inspection count by an amount equal to ten per cent of the correct quantity shipped. This process is not designed to represent all the complex nuances which might surround a given receiving and inspection operation in a real world situation. It is designed to represent the central tendency of a receiving and inspection department to understate recorded receipts because assumed employees are lax in performing physical test counts of all shipments received. This tendency certainly exists in a great many systems in the real world. A detailed explanation of the operating characteristics of the model related to the receiving and inspection operations is given in the variable name dictionary which appears in Appendix C.

Production Reporting of Units Produced

The inventory accounting and control system, described in the beginning of this paper, requires machine operators to record production counts of good units produced for each production order processed. These production counts are recorded on the raw material requisition, job time tickets and the number one copy of the production order applying to the particular production order being processed. As explained in the internal control review section of this paper, internal control over production reporting is assumed to be quite lax. Lax control over production counting procedures is considered in the design of the simulation model. This poor control is assumed to result in overstatements of production counts in Departments I and II. This situation is represented in the simulation model by stochastic processes.

The computer simulation program uses the Monte Carlo technique to determine which production orders are to be erroneously reported by the producing departments.

The stochastic process applying to Department I is designed in such a manner that each production order processed by Department I has a fifteen per cent chance of being recorded erroneously. When the simulation program determines that an error is to occur in the recording of a production count in Department I, it overstates the production count by ten per cent of the actual quantity produced.

The production reporting system described in the first part of this paper requires that the production counts of Department I be recorded on the number one copy of the original production order. This copy of the production order is attached to the units being produced. This number one copy of the production order follows the units throughout the manufacturing process. Erroneous production counts, recorded by Department I are assumed to be noted on this traveling production order. Thus, approximately fifteen per cent of the traveling orders are assumed to enter Department II with an overstated Department I production count written on the traveling production order. The simulation model is designed under the assumption that employees of Department II cover-up for overstatements made by employees of Department I. When an overstated production order enters Department II, the employees do not correct the Department I count. The Department II employees report the overstated Department I count as the Department II count. In the case of those orders not overstated by Department I, however, overstatements may arise in Department II.

The stochastic process applying to Department II is designed in such a manner that each production order (except those orders on which errors occurred in Department I) has an eight per cent chance of being erroneously reported. When the computer simulation program determines

that an error is to occur, it overstates the Department II production count by five per cent of the quantity actually produced.

The stochastic processes representing unreliable production reporting in Departments I and II are not designed to take into account all of the variables which might contribute to unreliable production reporting in a real world situation. The processes are designed to represent the central tendency of a system to overstate production counts given the assumed weaknesses in control. Machine operators are assumed to be prone to overstate production to achieve higher incentive wages and favorable labor efficiency variances. The model assumes that direct labor is always charged to the job at the target amount for the actual units produced. Thus, overstatements in the quantity reported as produced causes favorable labor efficiency variances to arise. As previously mentioned, the model does not maintain a record of the variances arising over the period. It is strictly concerned with accounting for inventory at standard costs. Overstated production counts therefore result in erroneous, overstatements of inventory.

Production Reporting; Material Requisitions

As indicated in Figure 5, the simulation model also includes processes which are assumed to represent the results of lax control exercised over the preparation and processing of raw material requisitions and the poor physical controls exercised over the raw materials storage area.

The simulation model is designed under the assumption that Department I machine operators always report a production count which is equal to the quantity of raw materials they requisition and receive for a production order. However, the model is further designed so that,

in the case of some production orders, it causes the machine operators actually to produce less units than they report. Where this occurs, an overstated production count results. It is assumed that machine operators are motivated to overstate production counts in order to achieve more favorable operating reports and higher incentive wages.

If a machine operator were to overstate production counts in accordance with the previously described procedure, the overstatement might be noticed by management because the machine operator would possess excessive raw materials. For the case of the hypothetical system and the system simulation model, it is assumed that machine operators conceal overstated production counts by returning the resultant excessive, unused raw materials to the raw materials storage area. The returns of excessive raw material are assumed to be unauthorized and not recorded on the firm's financial records. This violation of procedure can occur because (a) the Department I foreman does not check closely the recorded production counts, (b) poor control is exercised over the raw materials storage area, and (c) the weigh-count operation is not properly conducted.

A detailed description of the operating characteristics related to the processing of raw material requisitions is given in the variable name dictionary which appears in Appendix C. A detailed description of the manner in which the computer simulation program processes raw material requisitions is given in the procedural flow chart of Appendix A.

Production Reporting; Finished Goods Transfers

As indicated in Figure II-5, the computer simulation program transfers production orders, for each of the four products, from work-in-process to finished goods inventory. It accomplishes this work by

processing all the production orders for one product classification before proceeding to the next. For each of the four product classifications, the program chronologically transfers production orders until the control record of the accumulated total units transferred equals the pre-established total number of units to be transferred during the nine-month period. The specified limit for the total units transferred during the period is treated as a parameter of the model. This total number of units is given, for each of the four products, in Exhibit 3. All units not transferred are considered to be complete through Department II and are valued at full standard cost.

The simulation model is designed to represent the poor control exercised over finished goods transfers. The model transfers all production orders, except those overstated by more than twenty units, at the reported Department II production count figure. (As previously mentioned, however, the model uses control figures to determine the number of orders to be transferred.) Those production orders overstated by more than twenty units are corrected by the model to the actual control count. This process assumes that the weigh-count operator only corrects those production counts which are overstated by more than twenty units. He is assumed to be lax in correcting production count errors less than 21 units as machine operators are assumed to exert pressure on him when they are unable to overstate production counts.

The model representation of the transfer process is based upon one further assumption. The machine operators in Department II are assumed to change, obscure, or mutilate the traveling production order in those cases where the reported Department II production count exceeds the production count reported in Department I. This situation eliminates obvious

production count discrepancies and makes overstatements less apparent to the weigh-count operator. As the production counts noted on the number one copy of the production order are not compared to any other documents, errors go unnoticed unless the count error is in excess of twenty units.

Cost Accounting; Raw Material Receipts

The accounting procedures and controls related to pricing raw material receipts stipulate that the standard raw material price is entered on the accounts payable copy of the purchase order by the purchasing agent. The accounts payable clerk uses this price to voucher the raw material receipt for payment and entry to the inventory accounts. It has been assumed that no errors occur in the accounts payable vouchering process, but that poor control is exercised over the standard cost file.

Weak control over the standard cost file is included in the design of the simulation model. Poor control is assumed to result in the erroneous application of raw material price standards to the purchase order. This in turn results in erroneous vouchering of raw material receipts and incorrect entries to the raw materials inventory.

The procedures resulting in erroneous applications of raw material price standards are represented by the model as stochastic processes. The computer simulation program is designed to use the Monte Carlo technique to determine which raw material receipts are to be erroneously priced. The stochastic process is designed in such a manner that each receipt processed has a ten per cent chance of being erroneously priced. In processing a given receipt, the simulation program first determines whether or not a pricing error is to occur. If

the program determines that an error should occur, it applies the price standard for a similar raw material. If, on the other hand, the program determines that an error should not occur in pricing the shipment, it applies the correct price standard. The correct and erroneous raw material price standards are presented in Exhibit 7.

EXHIBIT 7

RAW MATERIAL PRICE STANDARDS; CORRECT AND ERRONEOUS

	Raw Material Number 1	Raw Material Number 2	Raw Material Number 3	Raw Material Number 4
Correct Price Standard	$ 13.50	$ 16.70	$ 6.50	$ 8.00
Erroneous Price Standard	$ 6.50	$ 8.00	$ 13.50	$ 16.70

As Figure 5 illustrates, an error in pricing a receipt of Raw Material I always results in the application of the correct price standard for Raw Material III and vice versa. The same reciprocal relationship is assumed for Raw Materials II and IV. This process is assumed to simulate a situation which might result from misfiled standard cost cards. It is assumed that Raw Materials I and III are similar to one another as are Raw Materials II and IV.

Cost Accounting; Job Time Tickets and Material Requisitions

Weak control over the standard cost file is also assumed to affect the reliability of accounting processes dealing with the application of standard costs to job time tickets and material requisitions. The procedures resulting in erroneous applications of standard costs are represented by the model as stochastic processes.

The accounting procedures and controls, relating to the preparation

and processing of job time tickets permit several job time tickets to be issued for any one production order. As previously described, job time tickets which apply to incomplete production orders are filed in the cost accounting department in a temporary file until the production order is completed. It is assumed that the cost accounting clerks consult the standard cost file only in the case of the first job time tickets issued by a given production department on a given production order. All subsequent job time tickets generated by the same department for the same production order are assumed to be costed by referring to the first job ticket generated. This assumption permits the model to process the entire series of job time tickets which apply to any one production order as if they were one job time ticket.

The computer simulation program is designed to process the job time tickets generated by Department I in the same manner that it processes the time tickets generated by Department II. The program uses the Monte Carlo technique to determine whether or not the job time tickets applying to a given production order are to be costed erroneously. The stochastic process is designed so that each production order has a ten per cent chance of an error occurring in the costing process. When the computer program determines that an error is to occur, it improperly applies to the job time ticket the direct labor hour and burden rates which apply to a similar product. The correct and erroneous standards are presented in Exhibit 8.

The computer program also uses the Monte Carlo technique to determine whether or not correct standard direct labor rates are to be applied to the job time ticket. The stochastic process relating to the application of direct labor rates is described in detail in the variable name

dictionary of Appendix C.

The simulation model represents the raw material requisition costing process in a manner similar to that described for job time tickets. A detailed description of the stochastic processes related to the costing of raw material requisitions is given in the variable name dictionary of Appendix C.

The stochastic processes applying to the costing of job time tickets and material requisitions are assumed to simulate the tendency of a system which might result from misfiled standard cost data.

The basic underlying assumption of the stochastic pricing process is that Product I and Product II both carry the same identical part number except that each of the two product's part numbers consists of a different alphabetic prefix. The alphabetic prefix specifies the metal alloy of the respective casting. The same similarities and differences are assumed for Products II and IV. Costing errors are thus assumed to occur for two basic reasons (a) the cost clerk confuses the alphabetic prefix and thus selects the part number with the inappropriate prefix, and (b) the clerk selects the part number with the inappropriate prefix because it has been misfiled in the inappropriate metal alloy category.

Cost Accounting; Finished Goods Transfers

The simulation model treats the standard costing process related to transfers from work-in-process to finished goods inventory, in a manner similar to that already explained for raw material receipts. The only significant difference is that unitized standard costs of material, labor and burden are used to relieve work-in-process inventory while total unit standard costs (material + labor + burden) are used to charge finished goods. The correct and erroneous standard cost parameters are

EXHIBIT 8

STANDARDS FOR PRODUCTION COSTING: CORRECT AND ERRONEOUS

	Product Number 1	Product Number 2	Product Number 3	Product Number 4
Direct Material				
Correct dir. material std.	$13.5000	$16.7000	$ 6.5000	$ 8.0000
Erroneous dir. material std.	$ 6.5000	$ 8.000	$13.5000	$16.7000
Direct Labor				
Correct std. dir. lbr. hrs./unit in Dept. I	.06	.09	.04	.06
Erroneous std. dir. lbr. hrs./unit in Dept. I	.04	.06	.06	.09
Correct std. dir. lbr. hrs./unit in Dept. II	.04	.06	.04	.07
Erroneous std. dir. lbr. hrs./unit in Dept. II	.04	.07	.04	.06
Correct std. dir. lbr. rate in Dept. I	$ 6.20	$ 6.20	$ 6.20	$ 6.20
Erroneous std. dir. lbr. rate Number I in Dept. I	$ 6.00	$ 6.00	$ 6.00	$ 6.00
Erroneous std. dir. lbr. rate Number II in Dept. I	$ 5.60	$ 5.60	$ 5.60	$ 5.60
Correct std. dir. lbr. rate in Dept. II	$ 5.60	$ 5.60	$ 5.60	$ 5.60
Erroneous std. dir. lbr. rate Number I in Dept. II	$ 5.40	$ 5.40	$ 5.40	$ 5.40
Erroneous std. dir. lbr. rate Number II in Dept. II	$ 6.20	$ 6.20	$ 6.20	$ 6.20

This Exhibit is continued on the next page.

EXHIBIT 8 (Continued)

STANDARDS FOR PRODUCTION COSTING; CORRECT AND ERRONEOUS

	Product Number 1	Product Number 2	Product Number 3	Product Number 4
Direct Labor (Continued)				
Correct std. dir. lbr. cost/unit	$ .5960	$ .8940	$ .4720	$ .7640
Erroneous std. dir. lbr. cost/unit	$ .4720	$ .7640	$ .5960	$ .8940
Burden				
Correct std. burden rates for Dept. I; in dollars/ std. dir. lbr. hr.	$ 12.85	$ 12.85	$ 11.40	$ 11.40
Erroneous std. burden rates for Dept. I; in dollars/ std. dir. lbr. hr.	$ 11.40	$ 11.40	$ 12.85	$ 12.85
Correct std. burden rates for Dept II; in dollars/ std. dir. lbr. hr.	$ 51.55	$ 51.55	$ 44.05	$ 44.05
Erroneous std. burden rates for Dept. II; in dollars/ std. dir. lbr. hr.	$ 44.05	$ 44.05	$ 51.55	$ 51.55
Correct std. burden cost/ unit	$ 2.8330	$ 4.2495	$ 2.2180	$ 3.7675
Erroneous std. burden cost/unit	$ 2.2180	$ 3.7675	$ 2.8330	$ 4.2495
Total Unit Standard Cost				
Correct unit std. cost	$ 16.9290	$21.8435	$ 9.1900	$12.5315
Erroneous unit std. cost	$ 9.1900	$12.5315	$16.9290	$21.8435

given in Exhibit 8.

DESCRIPTION OF THE DATA PRINTED BY THE SYSTEM SIMULATION PROGRAM

Samples of the data, printed out by the computer simulation program, are included as Appendix D. All of the data generated by the program are printed in summary form. The information included in the summaries represents the results of the entire nine-months activity. As previously explained, the information pertains only to activity related to the selected four products and their component raw materials.

The reference numbers used in the print-out summaries do not refer to actual document numbers which might be printed on any pre-numbered form. Instead, the shipment number, receiver number, order number and requisition number which appear on the summaries have been provided to facilitate cross-referencing between summaries.

All transactions and documents appearing on the summaries are assumed to be printed out in the same chronological sequence in which they were processed by the firm, e.g.: shipment number one, appearing on either of the shipment summaries represents the first shipment of Raw Material I received during the nine-month period. Receiver number one, which appears on the same summaries, is assumed to be the receiving form prepared for shipment number one. Thus, numerical character one, associated with receiver number one, is not meant to represent a document number. In the same shipment summaries, shipment number two hundred two represents the first shipment of Raw Material II received during the period. Shipment number two hundred three presents the second shipment of the Raw Material II received.

Explanation of the "Summary of Shipments Received and Receiving Forms Processed in Terms of Units"

This summary provides a detailed listing of all the shipments of the four raw materials received by the firm during the period. It also provides a corresponding list of the quantity counts noted on the receiving form prepared for each shipment.

The "type of material" column indicates which of the four raw materials was shipped. The "quantity shipped" column indicates how many units of the raw material were actually included in the shipment. This quantity is a CONTROL figure calculated by the model. The "quantity received" column contains a quantity which represents the count that the receiving and inspection personnel enter on the receiving form they prepare for the shipment. The model uses this count to process the shipment and update the raw material inventory.

Explanation of the "Summary of Shipments Received and Receiving Forms Processed, Priced, and Extended at Standard Cost"

This summary is a listing of the extended standard cost of each shipment which appears in the summary of shipments received and receiving reports processed. It is cross referenced to the unit shipment summary schedule. The "extended standard cost" column appearing on the left of the summary represents the CONTROL extension that the model computes for each shipment processed (actual quantity received multiplied by the correct raw material price standard). The "extended standard cost" column appearing on the right of the summary represents the extended standard cost that appears on the accounts payable voucher prepared for the shipment.

Explanation of the "Production Order Summary for the Period" for Departments One and Two

These summaries provide a detailed listing of data that represent the information that would result from the processing of all the job time tickets prepared during the period.

The "order number" appearing in the first column of the summary serves as a reference number to a particular production order. As an example: order number one refers to the first production order processed during the period for product one. Order number two hundred twenty-eight refers to the first production order processed during the period for product two. Order two hundred twenty-nine refers to the second production order processed during the period for product two.

The column labeled "units produced" contains the number of units of product actually produced on a given production order. The model uses this figure to maintain a CONTROL record of all transactions. The column labeled "units reported" contains a quantity which represents the production count that is noted on the job time tickets. This production count applies to the production order referenced by the order number.

The "direct labor hours reported" column contains an amount which represents the total direct labor hours charged to the production order. Machine operators enter this amount on the job time tickets they prepare. Direct-labor-hours-charged is stated at the target amount for the actual units produced. Target production is an assumption underlying the design of the simulation model.

The column headed "direct labor charged work-in-process" contains an amount representing the extended direct labor charge computed for the job time tickets applying to the production order. This amount is computed

by a cost accounting clerk. The cost clerk enters this amount on the job time tickets.

The column headed burden-in-process contains the extended burden charge computed for the job time tickets applying to the production order. It is computed in the same manner as the direct labor charge.

Explanation of the "Material Requisition Summary"

The material requisition summary provides a detailed listing of data which represents the information resulting from the preparation and processing of all the material requisitions prepared during the nine-month period.

The "requsition number" appearing in the first column of the summary serves the same purpose as the production order summary order number. Each requisition number applies to the material requisition prepared for the production order carrying the same number. The "type of material" column indicates the type of raw material requisitioned.

The "quantity used" column indicates the quantity of materials actually used in the manufacture of the production order carrying the same order number as the requisition number. The quantity used figure is a CONTROL figure. The "quantity requisitioned" column contains the quantity of material requisitioned for the manufacture of the corresponding production order. As previously explained, units representing the difference between the quantity requisitioned and the quantity used are assumed to be returned to raw materials stores by the machine operators.

The three columns of the summary labeled "charged to work-in-process" contain the information used to determine the standard cost

charge to the work-in-process inventory. The standard column contains the direct material standard used to compute the extended direct material charge applicable to the production order. This extended charge appears in the amount column. The far right column of the raw material requisition summary contains the extended credit to raw materials inventory, computed for the material requisition. The last four columns on the right of the summary represent the information that is noted on each material requisition by the cost accounting clerk. The information in the rightmost two columns is summarized and posted to the inventory accounts.

Explanation of the "Summary of Production Orders Transferred to Finished Goods"

The "summary of production orders transferred to finished goods" is a detailed summary of all production orders transferred from work-in-process to finished goods inventory during the period.

The "order number" serves the same purpose as the "order number" appearing in the production order summary. There is a one to one correspondence between production orders summarized in the production order summary and production orders listed in the transfer summary.

The "units transferred" column contains the actual number of units transferred for any given production order. The units transferred figure is a CONTROL figure calculated by the simulation model. It agrees to the figure in the "units produced" column of production summary. The "units reported as transferred" column contains a quantity which represents the number of units transferred, reported on the number one copy of the production order. As previously explained, this figure is entered on the production order by the weigh-count operator.

The rightmost four columns of the transfer summary represent the extended standard cost amount of inventory charges and credits. These amounts are computed by cost accounting clerks for each production order transferred. The cost accounting clerks enter the amounts on the number one copy of the transferred production order form. These charges and credits are summarized and posted to the inventory accounts.

Explanation of the "Final Summary Report"

The final summary report presents the ending inventories generated by the model in terms of units and at standard cost. In the left column labeled "reported," the unreliable REPORTED simulated results are presented. In the right column, labeled "control," the CONTROL figures are given. The CONTROL figures agree with the ending inventory balances presented in Exhibit 2, 3, and 5. The REPORTED figures naturally disagree with the CONTROL figures because of the stochastic processes which affect the processing of REPORTED results.

It is assumed that the only financial inventory accounts maintained by the company are total raw materials, total work-in-process, and total finished goods. More detailed results are presented in the final summary report so that the total combined operating characteristics of the model can be more easily understood.

FIGURE 6.

INVENTORY ACCOUNTING AND CONTROL
AUDIT PROGRAM

1. Ascertain the degree of accuracy of quantity counts recorded on the receiving form. For each shipment listed on the SUMMARY OF SHIPMENTS RECEIVED AND RECEIVING REPORTS PROCESSED IN TERMS OF UNITS, verify the quantity received by comparing it to the quantity shipped. List all exceptions on an audit work paper.

2. Determine the extent of the reliability of cost accounting procedures related to the pricing of raw materials received. For each shipment listed on the SUMMARY OF SHIPMENTS RECEIVED AND RECEIVING FORMS PROCESSES PRICED AND EXTENDED AT STANDARD COST, verify the extended standard cost computation. This can be accomplished by extending the quantity received (which appears on the UNIT shipment summary) by the correct standard material price. Standard material prices are presented in Exhibit 7. List all exceptions on an audit work paper.

3. Ascertain the degree of accuracy of the production counts reported by Departments I and II. For each production order listed on the PRODUCTION ORDER SUMMARY FOR THE PERIOD, perform the following procedures:

   a. Verify all of the production counts reported by Department I. This can be accomplished by comparing the units reported on the Department I summary to the units reported on the same summary. List all exceptions noted on an audit work paper.

   b. Having completed step "a" above, verify the production count reported by Department II. This can be accomplished by comparing the units reported on the Department II summary to both the units reported and the units produced for the corresponding production order appearing on the Department I summary.

   c. Determine the extent of the reliability of cost accounting procedures related to the costing of job time tickets. For each production order appearing on the PRODUCTION ORDER SUMMARY FOR THE PERIOD for Departments I and II, verify the extended labor and burden calculation. List all exceptions noted on an audit working paper. Correct labor and burden standards are presented in Exhibit 8.

4. Ascertain the degree of the reliability of accounting procedures and controls related to the processing of material requisitions. For each material requisition listed on the MATERIAL REQUISITION SUMMARY, perform the following procedures:

   a. Verify the quantity of material requisitioned as reported on each material requisition form processed during the period. This can be accomplished by comparing the "quantity requisitioned" on the MATERIAL REQUISITION SUMMARY to the "units reported" on the PRODUCTION ORDER SUMMARY FOR THE PERIOD FOR DEPARTMENT I. (There is a one to one correspondence between the material requisition number and the corresponding production order number). List all exceptions on an audit work paper.

   b. Ascertain the quantity of materials actually used to produce each production order processed during the period. The quantity of materials actually used to produce a given production order is the same as the "units produced" figure which appears on the PRODUCTION ORDER SUMMARY FOR THE PERIOD FOR DEPARTMENT I. List all cases where the quantity requisitioned differs from the quantity of raw materials used. Where the quantity requisitioned exceeds the quantity used, the difference can be assumed to represent unauthorized returns to raw materials stores. These unauthorized returns can further be assumed not to have been recorded on the financial records.

   c. Determine the extent of the reliability of cost accounting procedures related to the costing of all material requisitions processed during the period. Correct standard costs are presented in Exhibit 8. List all exceptions on an audit work paper.

5. Ascertain the degree of the reliability of accounting procedures and controls related to the processing of production orders transferred to finished goods inventory during the period. For each production order transferred during the period, listed on the SUMMARY OF PRODUCTION ORDERS TRANSFERRED TO FINISHED GOODS; perform the following procedures:

   a. Ascertain the degree of the effectiveness of the weigh-count operation. Verify the "units reported as transferred" by the weigh-count operator. This can be accomplished by comparing the "units reported as transferred" figure, for each production order transferred, to the "units transferred" figure which appear on the same summary. List all exceptions noted on an audit work paper.

   b. Ascertain the extent of the reliability of cost accounting procedures related to the costing of finished goods transfers. Verify the extended inventory charges and credits computed for each production order transferred. Correct standard costs are presented in Exhibit 8.

c. Determine the accuracy of adjustments made for correction notices generated by the weigh-count operation. Isolate all production orders for which correction notices were generated. This can be accomplished by comparing the "units reported as transferred" figure for each production order to the units reported figure on the PRODUCTION ORDER SUMMARY FOR THE PERIOD FOR DEPARTMENT II. Any differences constitute corrections. The firm adjusts for all correction notices by applying correct accumulated full standard cost to the difference in production count which has been disclosed by the weigh-counter. Determine whether or not this technique is appropriate for the order in question. List all exceptions on an audit work paper.

A P P E N D I X A

PROCEDURAL FLOW CHART

SYSTEM SIMULATION MODEL

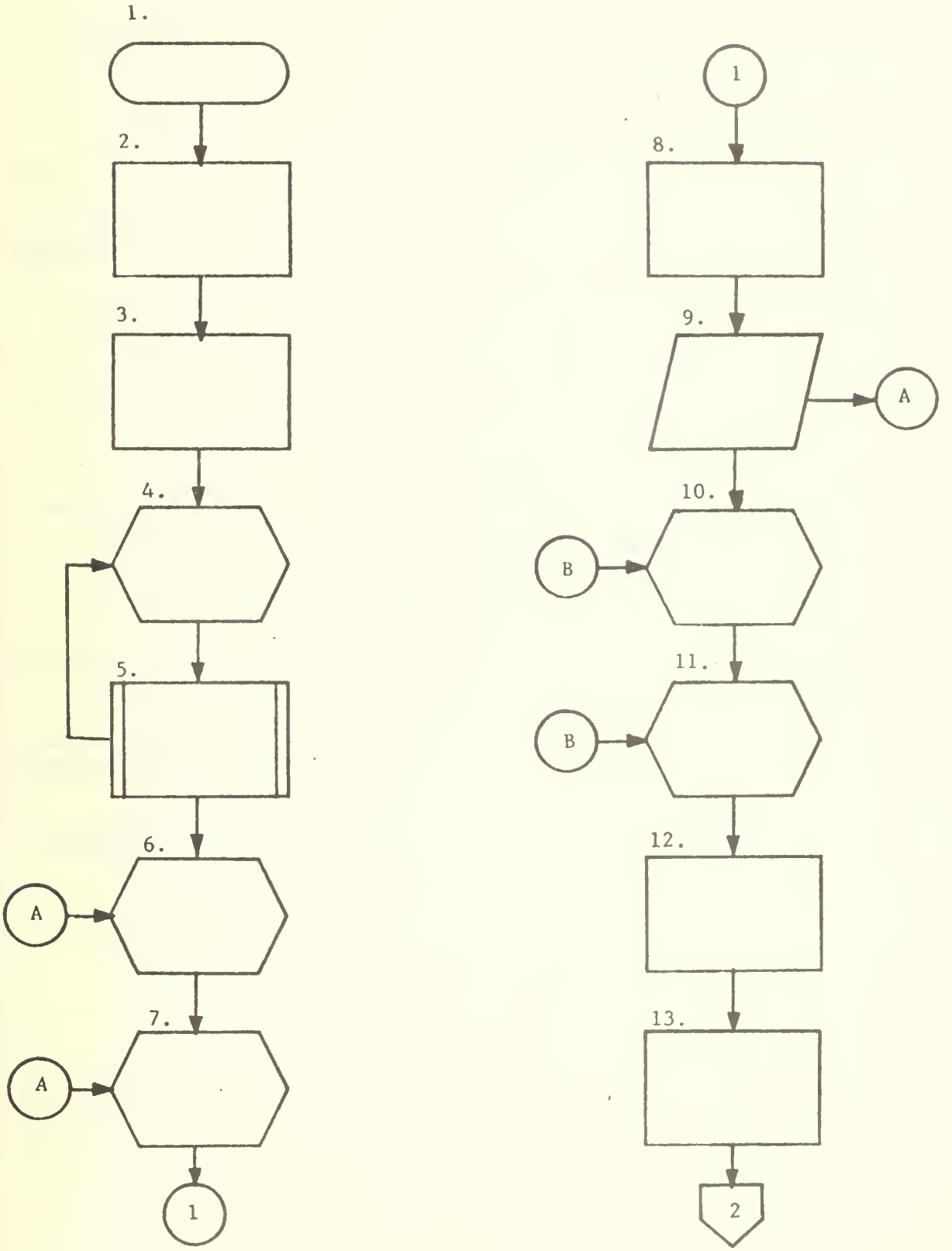
PROCEDURAL FLOW CHART
SYSTEM SIMULATION MODEL

DESCRIPTION OF THE PROCEDURES WHICH APPLY TO THE RESPECTIVE PROCESSING BLOCKS SHOWN ON THE OPPOSITE PAGE

FLOW CHART REFERENCE NUMBER	DESCRIPTION OF THE PROCEDURE
1.	Start program.
2.	Initialize computer memory.
3.	Set parameters in memory.
4.	DO; for each of the four types of raw material.
5.	Generate the actual quantity shipped for each raw material shipment received during the nine-month period.
6.	DO; for each of the four types of raw material.
7.	DO; for each shipment received during the nine-month period.
8.	Generate the unreliable quantities, assumed to be reported as received on the receiving form for each shipment.
9.	Print the SUMMARY OF SHIPMENTS RECEIVED AND RECEIVING REPORTS PROCESSED IN TERMS OF UNITS.
10.	DO; for each of the four types of raw material.
11.	DO; for each shipment received during the nine-month period.
12.	(a) Apply the correct raw material standard price to the quantity actually shipped. (b) Apply unreliable raw material standard prices to the quantities generated in step 8.
13.	Update the REPORTED financial raw material inventory account for the extended result of (b) in step 12; update the CONTROL financial material inventory account for the extended results of (b) step 12.

PROCEDURAL FLOW CHART

SYSTEM SIMULATION MODEL



14. Print the SUMMARY OF SHIPMENTS RECEIVED AND RECEIVING FORMS PROCESSED, PRICED AND EXTENDED AT STANDARD COST.

15. DO; for each of the four types of product.

16. Generate the quantity of units actually produced on a production order.

17. Generate unreliable production counts for Departments I and II which apply to the production order generated in step 16.

18. Compute unreliable Department I and II standard direct labor hours for the production order generated in step 16.

19. Compute the correct standard direct labor hours for the production order generated in step 16.

20. Is the accumulated quantity of units generated in step 16 equal to the total units to be produced for this product type?

21. DO; for each of the four types of products.

22. DO; for each production order previously generated.

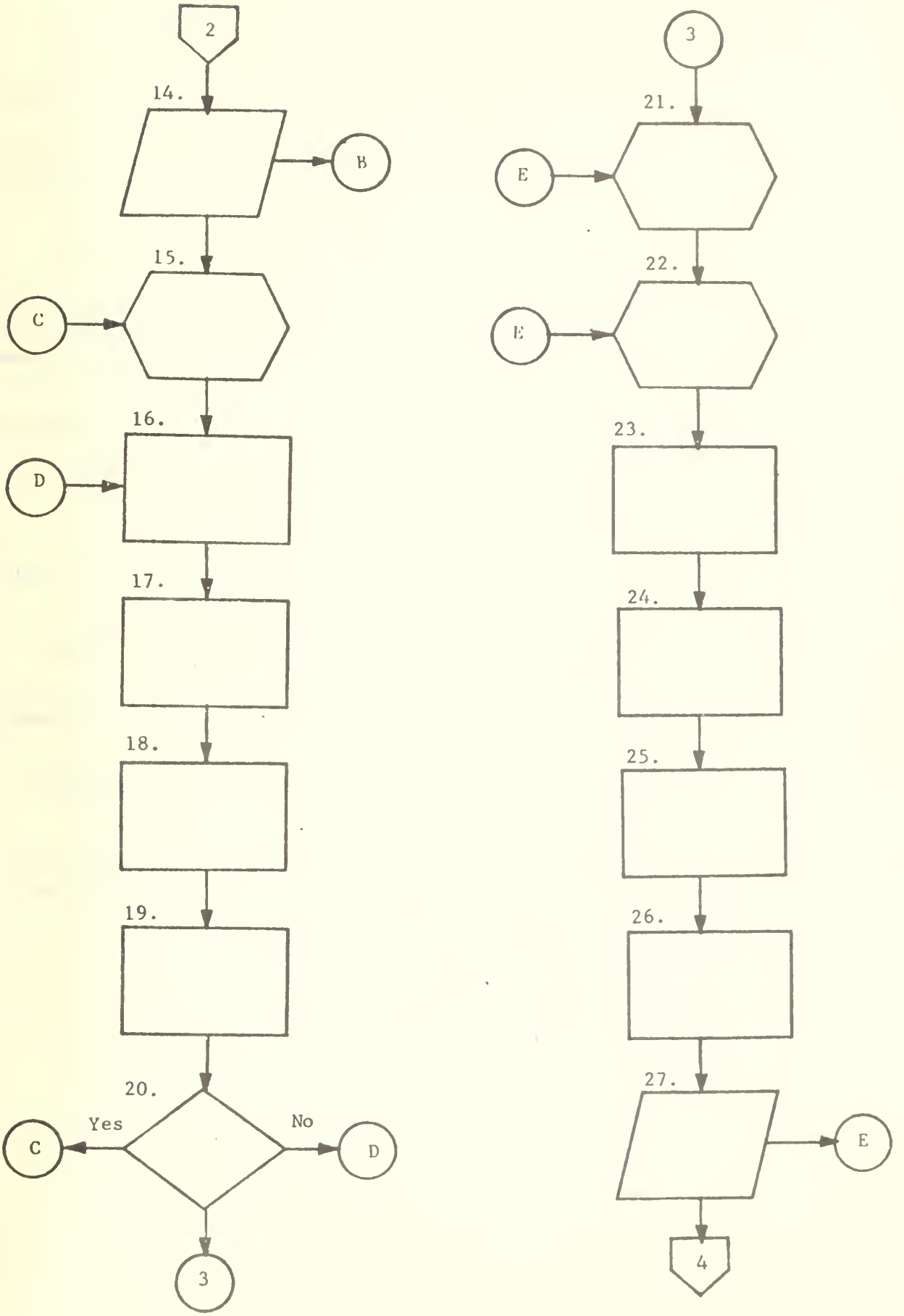
23. Compute the unreliable extended Department I direct labor charge for each production order generated in step 16.

24. Compute the unreliable extended Department I burden charge for each production order generated in step 16.

25. Compute the correct extended Department I direct labor and burden charges for each production order generated in step 16.

26. Update the REPORTED work-in-process inventory account for the unreliable charges determined in steps 23 and 24; update the CONTROL work-in-process account for the charges computed in step 25.

27. PRINT the PRODUCTION ORDER SUMMARY FOR THE PERIOD FOR DEPARTMENT 1.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28. DO; for each of the four types of product.

29. DO; for each production order previously generated in step 16.

30. Compute the unreliable extended Department II direct labor charge for each production order generated in step 16.

31. Compute the unreliable extended Department II burden charge for each production order generated in step 16.

32. Compute the correct extended Department II direct labor and burden charges for each production order generated in step 16.

33. Update the REPORTED work-in-process inventory account for the unreliable charges determined in steps 30 and 31; update the CONTROL work-in-process inventory account for the charges computed in step 32.

34. Print the PRODUCTION ORDER SUMMARY FOR THE PERIOD FOR DEPARTMENT II

35. DO; for each of the four types of product.

36. DO; for each production order generated in step 16.

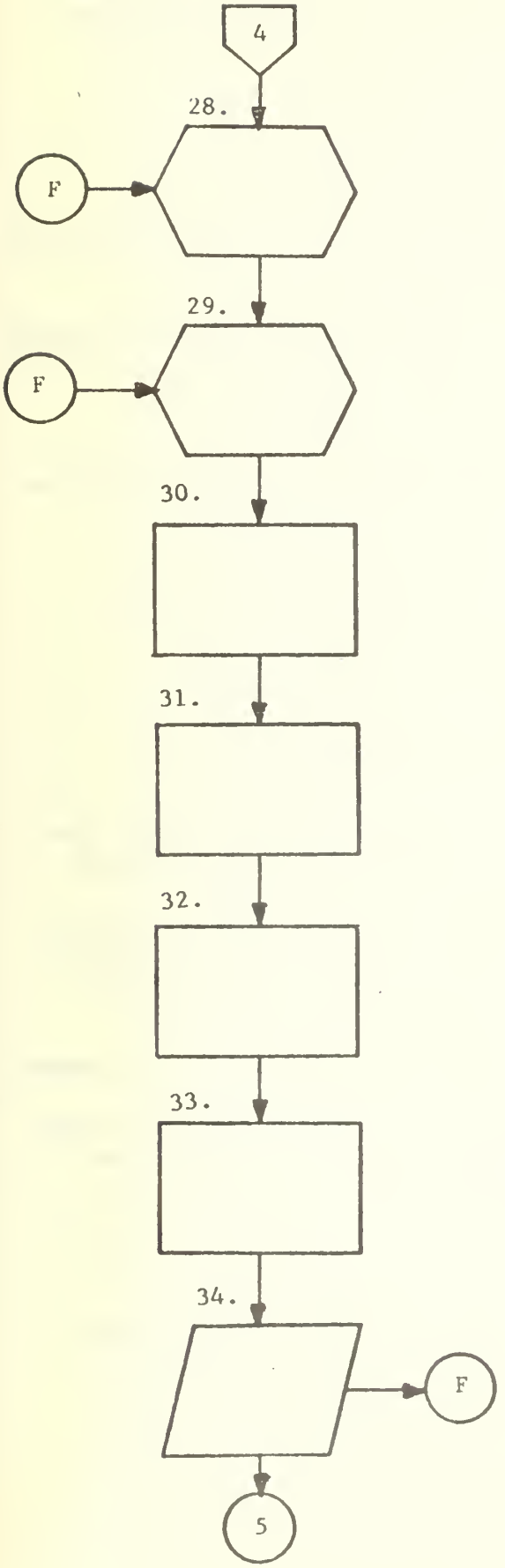
37. Determine the actual quantity of raw material used to produce the order.

38. Generate the quantity of raw material requisitioned to produce the production order.

39. Extend the quantities generated in step 38 by unreliable material standard costs.

40. Extend the quantities generated in step 37 by correct material standard costs.

41. Update the REPORTED work-in-process inventory for the unreliable credits computed in step 39; update the CONTROL work-in-process inventory for the credits computed in step 40.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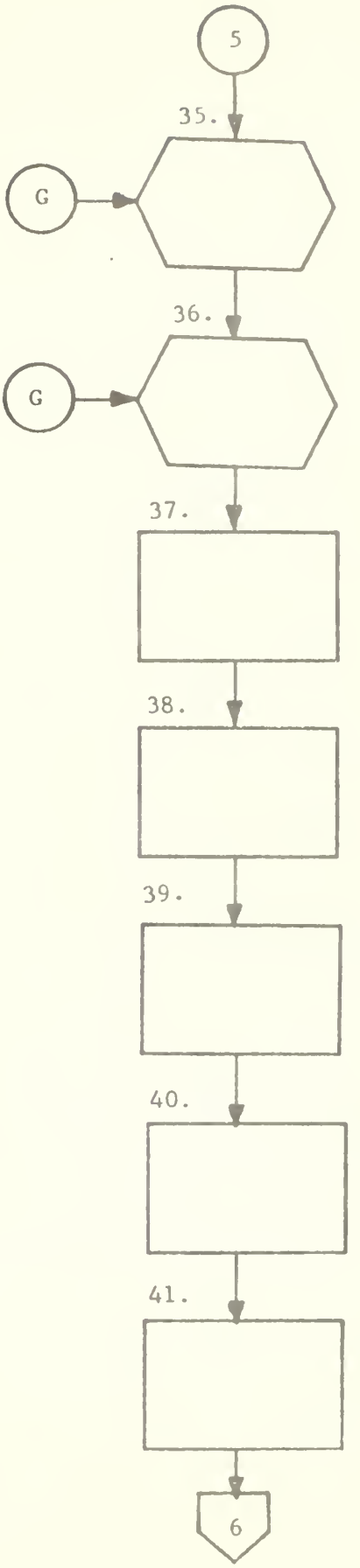
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42. Update the REPORTED perpetual unit records for the withdrawal of the quantities generated in step 38; udate the CONTROL perpetual unit records for the withdrawal of the quantities generated in step 37.

43. Print the MATERIAL REQUISITION SUMMARY.

44. DO; for each of the four types of raw material.

45. Calculate the ending balances for the REPORTED and CONTROL perpetual unit records of each type of raw material.

46. Calculate the ending balances for the REPORTED and CONTROL financial inventory accounts for raw materials, by raw material type.

47. DO; for each of the four types of raw material.

48. Calculate the ending balance for the REPORTED and CONTROL financial inventory account for all four raw materials combined.

49. DO; for each of the four types of product.

50. DO; for each production order scheduled to be transferred.

51. Is the Department II production count for this production order overstated by more than 20 units?

52. Correct the production count on this order.

53. Update the REPORTED and CONTROL finished goods perpetual unit records for the correct quantity of products actually transferred.

54. Update the REPORTED work-in-process perpetual unit records for the unreliable Department II production count; update the CONTROL work-in-process perpetual unit records for the actual quantity transferred.

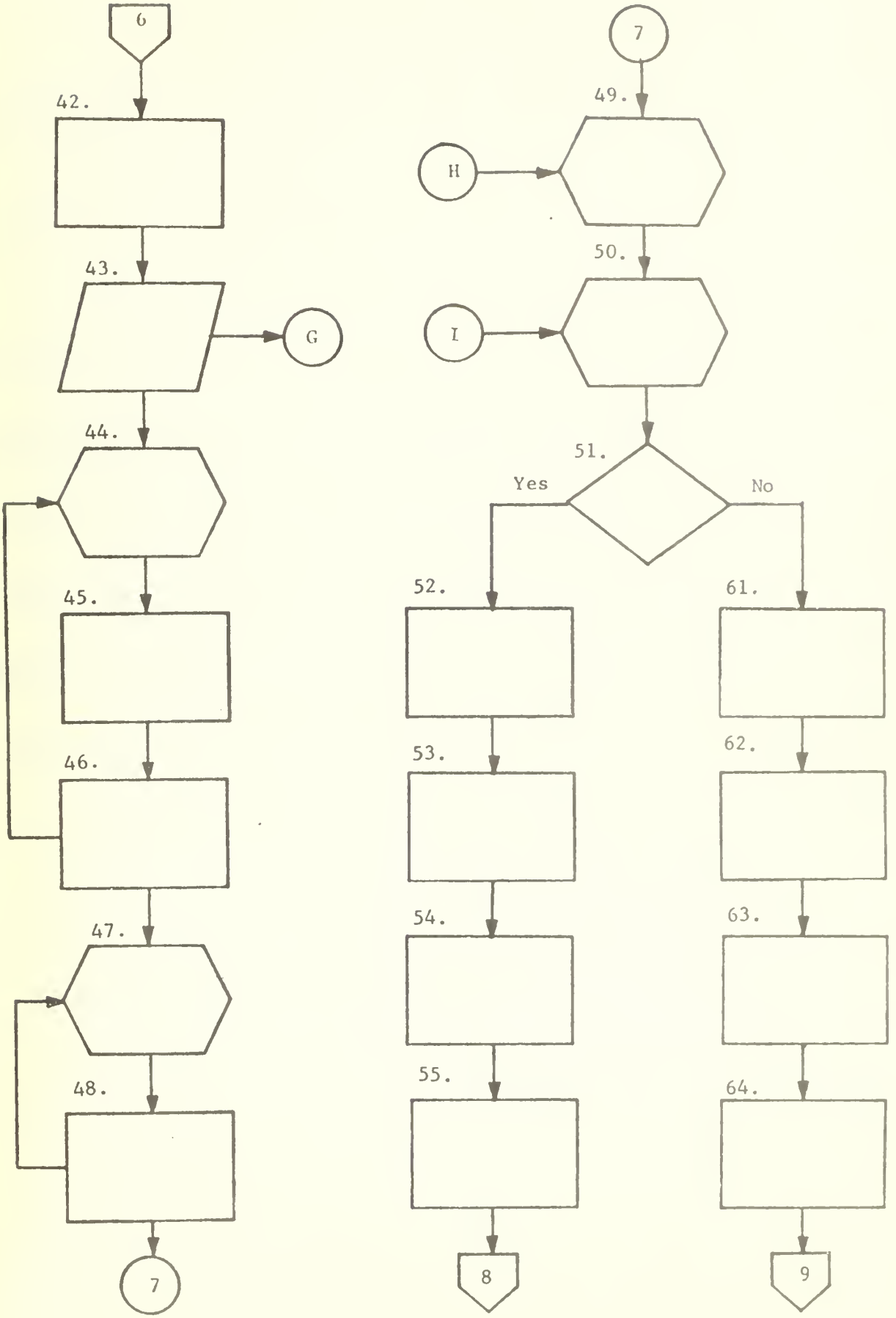
55. Apply unreliable standard costs to the production order transferred.

61. Update the REPORTED finished goods perpetual stock control records for the Department II production count transferred; update the CONTROL for the actual quantity transferred.

62. Update the REPORTED work-in-process perpetual unit records for the Department II production count transferred.

63. Apply unreliable standard costs to the Department II production count transferred.

64. Apply correct standard costs to the actual quantity of units transferred.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56. Apply correct standard costs to the actual number of units transferred.

57. Update the REPORTED finished goods inventory account for the extended values computed in step 55; update the CONTROL finished goods inventory account for the correct extended standard cost of the quantities actually transferred.

58. Update the CONTROL work-in-process inventory for the correct extended standard cost of the quantities actually transferred.

59. Update the REPORTED work-in-process inventory for the extended values computed in step 55.

60. Print the SUMMARY OF PRODUCTION ORDERS TRANSFERRED TO FINISHED GOODS.

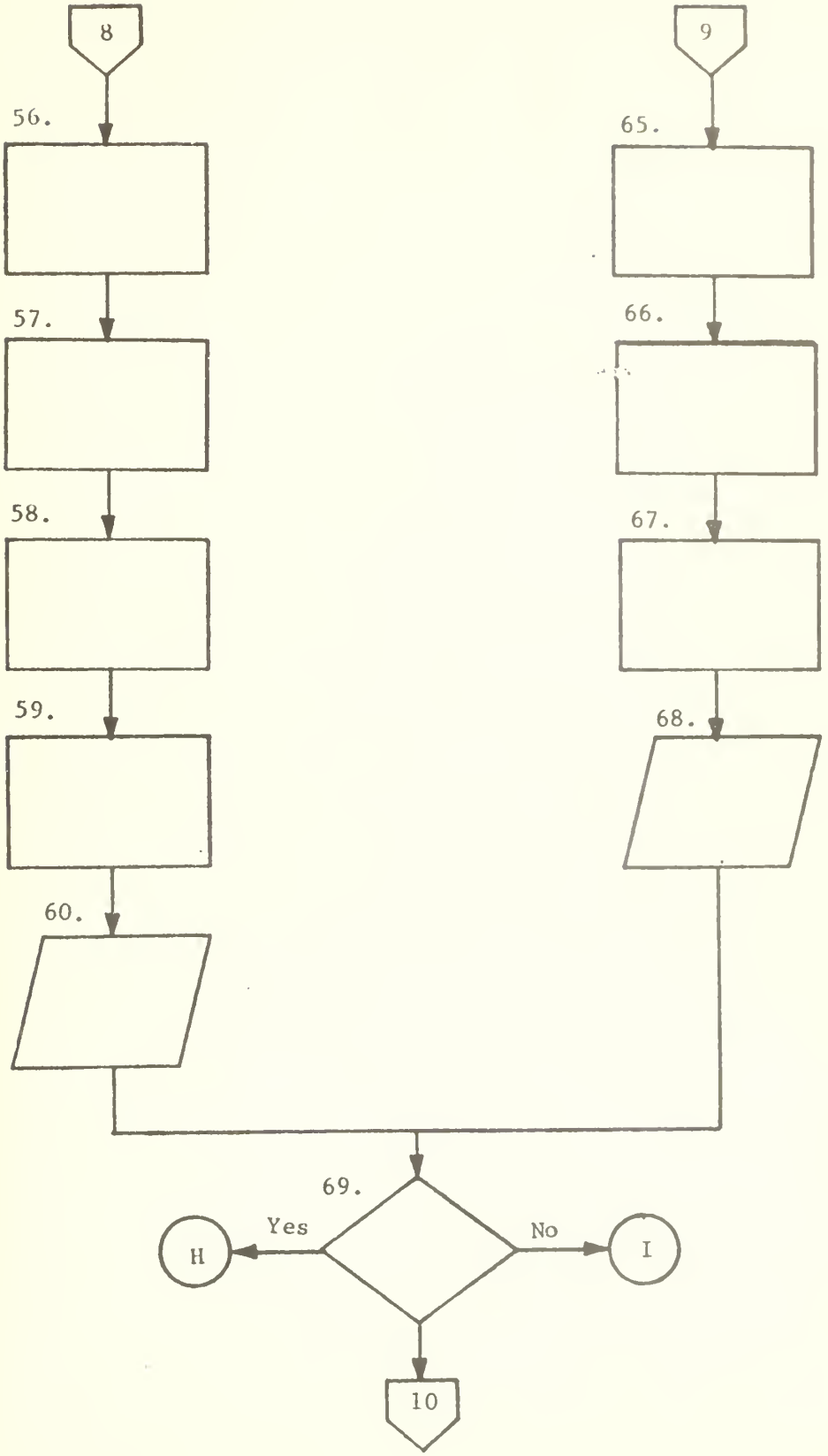
65. Update the REPORTED finished goods inventory for the extended values determined in step 63; update the CONTROL finished goods inventory for the extended values determined in step 64.

66. Update the CONTROL work-in-process inventory for the extended values determined in step 64.

67. Update the REPORTED work-in-process inventory for the extended values determined in step 63.

68. Print the SUMMARY OF PRODUCTION ORDERS TRANSFERRED TO FINISHED GOODS.

69. Have all the units, scheduled for transfer, been transferred?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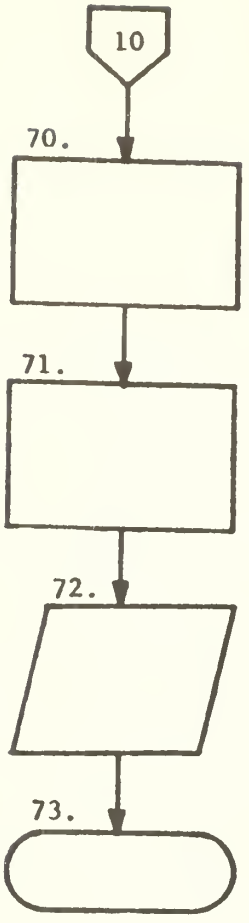
70. Determine the ending balances of the REPORTED and CONTROL finished goods inventories.

71. Determine the ending balances of the REPORTED and CONTROL work-in-process inventories.

72. Print the FINAL SUMMARY REPORT.

73. Stop the program.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A P P E N D I X B

COMPUTER PROGRAM OF THE SYSTEM SIMULATION MODEL

```
CARD #                                                                  PROCEDURAL FLOW CHART
                                                                        REFERENCE NUMBER
00001    JOB,7940,DCB,CM102000,T60.                                          1
00002    PAGES=200.                                                          1
00003    FTN.                                                                1
00004    REDUCE.   A REDUCE. CARD SHOULD APPEAR DIRECTLY BEFORE THE LGO. CARD.  1
00005    LGO.                                                                1
00006    &                                                                   1
00007          PROGRAM FRCST(INPUT,OUTPUT)                                   1
00008    C     ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
00009          COMMON/ONE/RM(4,450),EX(4),STD(4),RAW(4),NO(4),J              2
00010          DIMENSION PRAW(4,4),JOB(4,450),EJOB(4,450),WIP(4),NP(4)       2
00011          DIMENSION ERM(4,450),ETQMTL(4),TQMTL(4),ETMTL(4),SD(4,450),TMTL(4)  2
00012          DIMENSION DLH1(4,450),DLH2(4,450),SDLR(2,4),SDLH(4,2,2)       2
00013          DIMENSION EDLH1(4,450),EDLH2(4,450),EEJOB(4,450)              2
00014          DIMENSION CK1(4,450),CK2(4,450),QWIP1(4),QWIP2(4)             2
00015          DIMENSION SRR(4,2,2),RMRE(4),ERMRE(4),SUMAT1(4),SUMAT2(4)     2
00016          DIMENSION GWIP(4),EGWIP(4),TRAN(4),IFGQ(4),IFGCE(4)           2
00017          DIMENSION FGI(4),EFGI(4),STCPM(4,2),STCPL(4,2),STCPB(4,2)     2
00018          DIMENSION STCP(4,2)                                           2
00019          DIMENSION JOBC(4),ISPLIT(4)                                   2
00020          INTEGER P                                                     2
00021       33 FORMAT(*1*,//////,9X,*SUMMARY OF SHIPMENTS RECEIVED AND RECEIVING  2
00022         1REPORTS PROCESSED IN TERMS OF UNITS*)
00023       36 FORMAT(* *,9X,*-------------------------------------------------  2
00024         1----------------------------*)
00025       46 FORMAT(*0*,9X,*SHIPMENT*,4X,*TYPE OF*,3X,*QUANTITY*,10X,*RECEIVER*  2
00026         1,4X,*TYPE OF*,7X,*QUANTITY*)
00027       47 FORMAT(* *,11X,*NUMBER*,3X,*MATERIAL*,4X,*SHIPPED*,12X,*NUMBER*,3X  2
00028         1,*MATERIAL*,7X,*RECEIVED*)
00029       48 FORMAT(* *,11X,*------*,3X,*--------*,4X,*-------*,12X,*------*,3X  2
00030         1 ,*--------*,7X,*--------*)
00031       34 FORMAT(12X,I4,4X,I5,5X,F10.1,10X,I5,5X,I5,7X,F10.1)              2
00032       39 FORMAT(*1*,//////,9X,*SUMMARY OF SHIPMENTS RECEIVED AND RECEIVING  2
00033         1FORMS PROCESSED*)
00034       40 FORMAT(* *,20X,*PRICED AND EXTENDED AT STANDARD COST*)           2
00035       41 FORMAT(* *,9X,*-------------------------------------------------  2
00036         1--------*)
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00037          42 FORMAT(*0*,9X,*SHIPMENT*,3X,*EXTENDED*,21X,*RECEIVER*,3X,*EXTENDED  2
00038            1*)
00039          43 FORMAT(* *,11X,*NUMBER*,3X,*STD.COST*,23X,*NUMBER*,3X,*STD.COST*)   2
00040          44 FORMAT(* *,11X,*------*,3X,*--------*,23X,*------*,3X,*--------*)   2
00041          35 FORMAT(10X,I5,4X,F10.2,21X,I5,4X,F10.2)
00042          54 FORMAT(*1*,//////,9X,*PRODUCTION ORDER SUMMARY FOR THE PERIOD FOR   2
00043            1DEPARTMENT 1*)
00044          55 FORMAT(* *,9X,*-------------------------------------------------   2
00045            1---*)
00046          56 FORMAT(*0*,9X,*ORDER                UNITS     UNITS   DIRECT LBR.  D  2
00047            1IR.LBR.CHARGED   BURDEN CHARGED*)
00048          57 FORMAT(* *,11X,*NO.  PRODUCT  PRODUCED  REPORTED  HRS.REPORTED  WO   2
00049            1RK-IN-PROCESS  WORK-IN-PROCESS*)
00050          58 FORMAT(* *,9X,*-----  -------  --------  --------  -----------  -   2
00051            1-------------  --------------*)
00052          59 FORMAT(* *,5X,I9,I6,4X,I8,*.*,F10.0,F14.5,F12.2,F18.2)              2
00053          53 FORMAT(*1*,//////,9X,*PRODUCTION ORDER SUMMARY FOR THE PERIOD FOR   2
00054            1DEPARTMENT 2*)
00055         216 FORMAT(*1*,//////,9X,*MATERIAL REQUISITION SUMMARY*)                 2
00056         217 FORMAT(* *,9X,*-----------------------------*)                       2
00057         218 FORMAT(*0*,9X,*REQUISITION*,3X,*TYPE OF*,2X,*QUANTITY*,1X,*      Q  2
00058            1UANTITY*,3X,*CHARGED TO WORK-IN-PROCESS*,*  AMOUNT CREDITED*)
00059         219 FORMAT(* *,14X,*NUMBER*,2X,*MATERIAL*,6X,*USED*,2X,*REQUISITIONED*  2
00060            1, 3X,*QUANTITY STANDARD   AMOUNT    RAW MATERIALS*)
00061         220 FORMAT(* *,14X,*------*,2X,*--------*,6X,*----*,2X,*------------*   2
00062            1,3X,*-------- --------  ------  ---------------*)
00063         225 FORMAT(* *,5X,I15,I6,I14,I15,I11,F9.2,F9.2,F13.2)                    2
00064         300 FORMAT(*1*,//////,9X,*SUMMARY OF PRODUCTION ORDERS TRANSFERRED TO   2
00065            1FINISHED GOODS*)
00066         301 FORMAT(* *,8X,*-------------------------------------------------   2
00067            1-------*)
00068         302 FORMAT(* *,9X,*ORDER*,9X,*UNITS*,2X,*UNITS REPORTED*,2X,*EXTENDED   2
00069            1CHARGE  EXTENDED CREDIT TO W.I.P.*)
00070         303 FORMAT(* *,11X,*NO.*,2X,*PROD.*,1X,*TRANS.*,2X,*AS TRANSFERRED*,2X  2
00071            1,*FINISHED GOODS  MATERIAL  LABOR  BURDEN*)
00072         304 FORMAT(* *,9X,*-----*,2X,*----*,2X,*------*,2X,*--------------*,2X  2
00073            1,*---------------*,2X,*--------  -----  ------*)
```

```
00074        306 FORMAT(* *,9X,I5,I7,I7,*.*,F10.0,F18.2,F13.2,F7.2,F8.2,I5)                2
00075        226 FORMAT(*1*,//////,24X,*F I N A L  S U M M A R Y  R E P O R T*)            2
00076        227 FORMAT(*0*,13X,*RAW MATERIALS ENDING INVENTORY*,15X,*REPORTED              2
00077           1CONTROL*)
00078        229 FORMAT(* *,16X,*UNITS OF RAW MATERIAL*,I2,F27.2,F12.2)                    2
00079        261 FORMAT(*0*)                                                               2
00080        231 FORMAT(* *,16X,*STD.COST OF RAW MATERIAL*,I2,1X,*INVENTORY*,F14.2,        2
00081           1F12.2)
00082        232 FORMAT(* *,13X,*TOTAL STD.COST OF RAW MATERIAL INVENTORY*,F13.2,F1        2
00083           12.2)
00084        262 FORMAT(*0*,13X,*WORK-IN-PROCESS ENDING INVENTORY*,13X,*REPORTED           2
00085           1  CONTROL*)
00086        263 FORMAT(* *,16X,*UNITS OF PRODUCT*,I2,20X,F12.2,F12.2)                     2
00087        265 FORMAT(*0*,16X,*STD.COST OF MATERIAL-IN-PROCESS*,5X,F14.2,F12.2)          2
00088        266 FORMAT(* *,16X,*STD.COST OF LABOR-IN-PROCESS*,10X,F12.2,F12.2)           2
00089        267 FORMAT(* *,16X,*STD.BURDEN CONTENT OF WORK-IN-PROCESS*,F13.2,F12.2       2
00090           1)
00091        268 FORMAT(* *,13X,*TOTAL STD.COST OF WORK-IN-PROCESS*,F20.2,F12.2)           2
00092        271 FORMAT(*0*,13X,*FINISHED GOODS ENDING INVENTORY*,14X,*REPORTED*,5X        2
00093           1,*CONTROL*)
00094        272 FORMAT(* *,13X,*TOTAL STD.COST OF FINISHED GOODS*,8X,F13.2,,F12.2)        2
00095        307 FORMAT(* *,16X,*UNITS OF PRODUCT*,I2,20X,I9,*.00*,I9,*.00*)               2
00096        401 FORMAT(* *,9X,I5,I7,*   ORDER NOT TRANSFERRED DURING THE PERIOD*)        2
00097       1000 FORMAT(//////////,20X,*THE RANDOM NUMBER SEED IS*,O20)                    2
00098            DO775I=1,4                                                               2
00099            NO(I)=0                                                                  2
00100            JOBC(I)=0                                                                2
00101            ETMTL(I)=0.0                                                             2
00102            ETGMTL(I)=0.0                                                            2
00103            TGMTL(I)=0.0                                                             2
00104            TMTL(I)=0.0                                                              2
00105            ERMRE(I)=0.0                                                             2
00106            RMRE(I)=0.0                                                              2
00107            SUMAT2(I)=0.0                                                            2
00108            SUMAT1(I)=0.0                                                            2
00109        775 NP(I)=0                                                                  2
00110            DO778J=1,4                                                               2
```

```
00111            DO778K=1,450                                                2
00112            EDLH1(J,K)=0.0                                              2
00113            EDLH2(J,K)=0.0                                              2
00114            CK1(J,K)=0.0                                                2
00115            CK2(J,K)=0.0                                                2
00116            JOB(J,K)=0                                                  2
00117            EJOB(J,K)=0.0                                               2
00118            RM(J,K)=0.0                                                 2
00119            ERM(J,K)=0.0                                                2
00120            S D(J,K)=0.0                                                2
00121            EEJOB(J,K)=0.0                                              2
00122            DLH1(J,K)=0.0                                               2
00123        778 DLH2(J,K)=0.0                                               2
00124            RAW(1)=40000.                                               3
00125            RAW(2)=34000.                                               3
00126            RAW(3)=34000.                                               3
00127            RAW(4)=32000.                                               3
00128            TMTL(1)=108000.                                             3
00129            TMTL(2)=133600.                                             3
00130            TMTL(3)=45500.                                              3
00131            TMTL(4)=52000.                                              3
00132            TGMTL(1)=8000.                                              3
00133            TGMTL(2)=8000.                                              3
00134            TGMTL(3)=7000.                                              3
00135            TGMTL(4)=6500.                                              3
00136            WIP(1)=33600.                                               3
00137            WIP(2)=33000.                                               3
00138            WIP(3)=33000.                                               3
00139            WIP(4)=28900.                                               3
00140            WIPM=0.0                                                    3
00141            WIPL=0.0                                                    3
00142            WIPB=0.0                                                    3
00143            GWIP1(1)=0.0                                                3
00144            GWIP1(2)=0.0                                                3
00145            GWIP1(3)=0.0                                                3
00146            GWIP1(4)=0.0                                                3
00147            GWIP2(1)=0.0                                                3
```

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00148          GWIP2(2)=0.0                                                    3
00149          GWIP2(3)=0.0                                                    3
00150          GWIP2(4)=0.0                                                    3
00151          EX(1)=200.                                                      3
00152          EX(2)=180.                                                      3
00153          EX(3)=200.                                                      3
00154          EX(4)=180.                                                      3
00155          STD(1)=25.                                                      3
00156          STD(2)=30.                                                      3
00157          STD(3)=25.                                                      3
00158          STD(4)=30.                                                      3
00159          PRAW(1,2)=6.50                                                  3
00160          PRAW(1,4)=13.50                                                 3
00161          PRAW(2,2)=8.00                                                  3
00162          PRAW(2,4)=16.70                                                 3
00163          PRAW(3,2)=13.50                                                 3
00164          PRAW(3,4)=6.50                                                  3
00165          PRAW(4,2)=16.70                                                 3
00166          PRAW(4,4)=8.00                                                  3
00167          STCPL(1,1)=0.5960                                               3
00168          STCPL(1,2)=0.4720                                               3
00169          STCPL(2,1)=0.8940                                               3
00170          STCPL(2,2)=0.7640                                               3
00171          STCPL(3,1)=0.4720                                               3
00172          STCPL(3,2)=0.5960                                               3
00173          STCPL(4,1)=0.7640                                               3
00174          STCPL(4,2)=0.8940                                               3
00175          SDLH(1,1,1)=.06                                                 3
00176          SDLH(1,1,2)=.04                                                 3
00177          SDLH(1,2,1)=.04                                                 3
00178          SDLH(1,2,2)=.04                                                 3
00179          SDLH(2,1,1)=.09                                                 3
00180          SDLH(2,1,2)=.06                                                 3
00181          SDLH(2,2,1)=.06                                                 3
00182          SDLH(2,2,2)=.07                                                 3
00183          SDLH(3,1,1)=.04                                                 3
00184          SDLH(3,1,2)=.06                                                 3
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00185           SDLH(3,2,1)=.04                                                 3
00186           SDLH(3,2,2)=.04                                                 3
00187           SDLH(4,1,1)=.06                                                 3
00188           SDLH(4,1,2)=.09                                                 3
00189           SDLH(4,2,1)=.07                                                 3
00190           SDLH(4,2,2)=.06                                                 3
00191           SBR(1,1,1)=12.85                                                3
00192           SBR(1,1,2)=11.40                                                3
00193           SBR(1,2,1)=51.55                                                3
00194           SBR(1,2,2)=44.05                                                3
00195           SBR(2,1,1)=12.85                                                3
00196           SBR(2,1,2)=11.40                                                3
00197           SBR(2,2,1)=51.55                                                3
00198           SBR(2,2,2)=44.05                                                3
00199           SBR(3,1,1)=11.40                                                3
00200           SBR(3,1,2)=12.85                                                3
00201            SBR(3,2,1)=44.05                                               3
00202           SBR(3,2,2)=51.55                                                3
00203           SBR(4,1,1)=11.40                                                3
00204           SBR(4,1,2)=12.85                                                3
00205            SBR(4,2,1)=44.05                                               3
00206           SBR(4,2,2)=51.55                                                3
00207           TRAN(1)=30280.                                                  3
00208           TRAN(2)=30964.                                                  3
00209           TRAN(3)=29777.                                                  3
00210           TRAN(4)=21719.                                                  3
00211           STCP(1,1)=16.9290                                               3
00212           STCP(1,2)=9.1900                                                3
00213           STCP(2,1)=21.8435                                               3
00214           STCP(2,2)=12.5315                                               3
00215           STCP(3,1)=9.1900                                                3
00216           STCP(3,2)=16.9290                                               3
00217           STCP(4,1)=12.5315                                               3
00218           STCP(4,2)=21.8435                                               3
00219           STCPM(1,1)=13.5000                                              3
00220           STCPM(1,2)=6.5000                                               3
00221           STCPM(2,1)=16.7000                                              3
```

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00222          STCPM(2,2)=8.000                                          3
00223          STCPM(3,1)=6.5000                                         3
00224          STCPM(3,2)=13.5000                                        3
00225          STCPM(4,1)=8.0000                                         3
00226          STCPM(4,2)=16.7000                                        3
00227          STCPB(1,1)=2.8330                                         3
00228          STCPB(1,2)=2.2180                                         3
00229          STCPB(2,1)=4.2495                                         3
00230          STCPB(2,2)=3.7675                                         3
00231          STCPB(3,1)=2.2180                                         3
00232          STCPB(3,2)=2.8330                                         3
00233          STCPB(4,1)=3.7675                                         3
00234          STCPB(4,2)=4.2495                                         3
00235          IFGG(1)=4000-30600                                        3
00236          IFGG(2)=4500-31000                                        3
00237          IFGG(3)=6000-29000                                        3
00238          IFGG(4)=5000-21500                                        3
00239          IFGGE(1)=4000-30600                                       3
00240          IFGGE(2)=4500-31000                                       3
00241          IFGGE(3)=6000-29000                                       3
00242          IFGGE(4)=5000-21500                                       3
00243          FGI(1)=67716.00                                           3
00244          FGI(2)=98295.75                                           3
00245          FGI(3)=55140.00                                           3
00246          FGI(4)=62657.50                                           3
00247          EFGI(1)=67716.00                                          3
00248          EFGI(2)=98295.75                                          3
00249          EFGI(3)=55140.00                                          3
00250          EFGI(4)=62657.50                                          3
00251          SDLR(1,1)=6.00                                            3
00252          SDLR(1,2)=5.60                                            3
00253          SDLR(1,4)=6.20                                            3
00254          SDLR(2,1)=5.40                                            3
00255          SDLR(2,2)=6.20                                            3
00256          SDLR(2,4)=5.60                                            3
00257          FGMCH=0.0                                                 3
00258          CWIPCL=0.0                                                3
```

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00259          CWIPCB=0.0                                                    3
00260          WIPLE=0.0                                                     3
00261          WIPBE=0.0                                                     3
00262          FTMTL=0.0                                                     3
00263          EFTMTL=0.0                                                    3
00264          EFG=-1731113.15                                               3
00265          FG=-1731113.15                                                3
00266          DO4J=1,4                                                      4
00267        4 CALL INVCIC                                                   5
00268          PRINT 33                                                      9
00269          PRINT 36                                                      9
00270          PRINT 46                                                      9
00271          PRINT 47                                                      9
00272          PRINT 48                                                      9
00273          N=0                                                           9
00274          M=0                                                           9
00275          DO7J=1,4                                                      6
00276          I=NO(J)                                                       7
00277          DO7K=1,I                                                      7
00278          ERROR=RAN(0)                                                  8
00279          IF(ERROR.LT..25) GO TO 8                                      8
00280          ERM(J,K)=RM(J,K)                                              8
00281          GO TO 10                                                      9
00282        8 MISCOU=RM(J,K)*.10                                            8
00283          ERM(J,K)=RM(J,K)-MISCOU                                       8
00284          MISCOU=0                                                      8
00285       10 N=N+1                                                         9
00286          M=M+1                                                         9
00287          IF(M.EQ.35) GO TO 49                                          9
00288          GO TO 50                                                      9
00289       49 PRINT 33                                                      9
00290          PRINT 36                                                      9
00291          PRINT 46                                                      9
00292          PRINT 47                                                      9
00293          PRINT 48                                                      9
00294          M=0                                                           9
00295       50 PRINT 34,N,J,RM(J,K),N,J,ERM(J,K)                             9
```

```
00296        7 CONTINUE                                                    6
00297          PRINT 39                                                    14
00298          PRINT 40                                                    14
00299          PRINT 41                                                    14
00300          PRINT 42                                                    14
00301          PRINT43                                                     14
00302          PRINT 44                                                    14
00303          M=0                                                         14
00304          N=0                                                         14
00305          DO17I=1,4                                                   10
00306          ETGMTL(I)=TGMTL(I)                                          13
00307          ETMTL(I)=TMTL(I)                                            13
00308          IN=NO(I)                                                    11
00309          DO17J=1,IN                                                  11
00310          RN5=RAN(0)                                                  12
00311          IF(RN5.LT..90) GO TO 20                                     12
00312          S D(I,J)=PRAW(I,2)                                          12
00313          GO TO 26                                                    13
00314       20 S D(I,J)=PRAW(I,4)                                          12
00315          GO TO 26                                                    13
00316       26 ETGMTL(I)=ETGMTL(I)+ERM(I,J)                                13
00317          ETMTL(I)=ETMTL(I)+(ERM(I,J)*SD(I,J))                        13
00318          TGMTL(I)=TGMTL(I)+RM(I,J)                                   13
00319          TMTL(I)=TMTL(I)+(RM(I,J)*PRAW(I,4))                         12,13
00320          ERM(I,J)=ERM(I,J)*SD(I,J)                                   12
00321          RM(I,J)=RM(I,J)*PRAW(I,4)                                   12
00322          N=N+1                                                       14
00323          M=M+1                                                       14
00324          IF(M.EQ.35) GO TO 51                                        14
00325          GO TO 52                                                    14
00326       51 PRINT 39                                                    14
00327          PRINT 40                                                    14
00328          PRINT 41                                                    14
00329          PRINT 42                                                    14
00330          PRINT 43                                                    14
00331          PRINT 44                                                    14
00332          M=C                                                         14
```

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00333          52 PRINT 35,N,RM(I,J),N,ERM(I,J)                                  14
00334          17 CONTINUE                                                       10
00335             P=0                                                            18
00336             DO22I=1,4                                                      15
00337             J=1                                                            16
00338             TOT3=0.0                                                       20
00339          23 RN7=RAN(0)                                                     16
00340             RN8=RAN(0)                                                     16
00341             X2=(SQRT (-2.*ALOG(RN7)))*(COS (2.*3.14159*(RN8)))             16
00342             JOB(I,J)=X2*35.0+150.0                                         16
00343             DLH1(I,J)=JOB(I,J)*SDLH(I,1,1)                                 19
00344             DLH2(I,J)=JOB(I,J)*SDLH(I,2,1)                                 19
00345             RN9=RAN(0)                                                     17
00346             IF(RN9.LT..15) GO TO 141                                       17
00347             EJOB(I,J)=JOB(I,J)                                             17
00348             EEJOB(I,J)=EJOB(I,J)                                           17
00349             RN21=RAN(0)                                                    18
00350             IF(RN21.LT..08) GO TO 200                                      18
00351             P=1                                                            18
00352             GO TO 201                                                      18
00353          200 P=2                                                           18
00354          201 EDLH2(I,J)=EEJOB(I,J)*SDLH(I,2,P)                             18
00355             CK2(I,J)=P                                                     18
00356             RN21=RAN(0)                                                    18
00357             IF(RN21.LT..08) GO TO 202                                      18
00358             P=1                                                            18
00359             GO TO 203                                                      18
00360          202 P=2                                                           18
00361          203 EDLH1(I,J)=EJOB(I,J)*SDLH(I,1,P)                              18
00362             CK1(I,J)=P                                                     18
00363             RN10=RAN(0)                                                    17
00364             IF(RN10.LT..08) GO TO 142                                      17
00365             EEJOB(I,J)=EJOB(I,J)                                           17
00366             GO TO 25                                                       17
00367          142 MISCOU=EJOB(I,J)*.05                                          17
00368             EEJOB(I,J)=EJOB(I,J)+MISCOU                                    17
00369             RN21=RAN(0)                                                    18
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```
00370           IF(RN21.LT..08) GO TO 206                                18
00371           P=1                                                      18
00372           GO TO 207                                                18
00373       206 P=2                                                      18
00374       207 EDLH2(I,J)=EEJOB(I,J)*SDLH(I,2,P)                        18
00375           CK2(I,J)=P                                               18
00376           GO TO 25                                                 17
00377       141 MISCOU=JOB(I,J)*.10                                      17
00378           EJOB(I,J)=JOB(I,J)+MISCOU                                17
00379           EEJOB(I,J)=EJOB(I,J)                                     17
00380           RN21=RAN(0)                                              18
00381           IF(RN21.LT..08) GO TO 208                                18
00382           P=1                                                      18
00383           GO TO 209                                                18
00384       208 P=2                                                      18
00385       209 EDLH1(I,J)=EJOB(I,J)*SDLH(I,1,P)                         18
00386           CK1(I,J)=P                                               18
00387           RN21=RAN(0)                                              18
00388           IF(RN21.LT..08) GO TO 210                                18
00389           P=1                                                      18
00390           GO TO 211                                                18
00391       210 P=2                                                      18
00392       211 EDLH2(I,J)=EEJOB(I,J)*SDLH(I,2,P)                        18
00393           CK2(I,J)=P                                               18
00394        25 MISCOU=0                                                 17
00395           TOT4=TOT3+JOB(I,J)                                       20
00396           IF(TOT4.GE.WIP(I))GO TO 24                               20
00397           TOT3=TOT4                                                20
00398           J=J+1                                                    16
00399           GO TO 23                                                 16
00400        24 JOB(I,J)=WIP(I)-TOT3                                     16
00401           EJOB(I,J)=JOB(I,J)                                       17
00402           EEJOB(I,J)=EJOB(I,J)                                     17
00403           DLH1(I,J)=JOB(I,J)*SDLH(I,1,1)                           19
00404           RN21=RAN(0)                                              18
00405           IF(RN21.LT..08) GO TO 212                                18
00406           P=1                                                      18
```

```
00407          GO TO 213                                                    18
00408      212 P=2                                                          18
00409      213 EDLH1(I,J)=EJOB(I,J)*SDLH(I,1,P)                             18
00410          CK1(I,J)=P                                                   18
00411          DLH2(I,J)=JOB(I,J)*SDLH(I,2,1)                               19
00412          RN21=RAN(0)                                                  18
00413          IF(RN21.LT..08) GO TO 214                                    18
00414          P=1                                                          18
00415          GO TO 215                                                    18
00416      214 P=2                                                          18
00417      215 EDLH2(I,J)=EEJOB(I,J)*SDLH(I,2,P)                            18
00418          CK2(I,J)=P                                                   18
00419          NP(I)=J                                                      16
00420       22 CONTINUE                                                     16
00421          PRINT 54                                                     27
00422          PRINT 55                                                     27
00423          PRINT 56                                                     27
00424          PRINT57                                                      27
00425          PRINT 58                                                     27
00426          LL=0                                                         27
00427          L=0                                                          27
00428          DO60I=1,4                                                    21
00429          NI=NP(I)                                                     22
00430          DO60J=1,NI                                                   22
00431          LL=LL+1                                                      27
00432          L=L+1                                                        27
00433          P=CK1(I,J)                                                   23
00434          IF(LL.EQ.35) GO TO  72                                       27
00435          GO TO 73                                                     23
00436       72 PRINT 54                                                     27
00437          PRINT 55                                                     27
00438          PRINT 56                                                     27
00439          PRINT 57                                                     27
00440          PRINT 58                                                     27
00441          LL=0                                                         27
00442          GO TO 73                                                     23
00443       73 RN11=RAN(0)                                                  23
```

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00444            IF(RN11.LT..90) GC TO 71                                    23
00445            RN12=RAN(0)                                                 23
00446            IF(RN12.LT..50) GC TO 70                                    23
00447            WIPCH=EDLH1(I,J)*SDLR(1,2)                                  23
00448            WIPCHB=EDLH1(I,J)*SBR(I,1,P)                                24
00449            WIPLE=WIPLE+WIPCH                                           26
00450             WIPBE=WIPBE+WIPCHB                                         26
00451            RATE=SDLR(1,2)                                              23
00452            CWIPCL=CWIPCL+DLH1(I,J)*SDLR(1,4)                           25,26
00453            CWIPCB=CWIPCB+DLH1(I,J)*SBR(I,1,1)                          25,26
00454            X=DLH1(I,J)*SDLR(1,4)
00455             X2=DLH1(I,J)*SBR(I,1,1)
00456            PRINT 59,L,I,JOB(I,J), EJOB(I,J),DLH1(I,J),WIPCH,WIPCHB     27
00457            GO TO 60                                                    21
00458        70  WIPCH=EDLH1(I,J)*SDLR(1,1)                                  23
00459            WIPCHB=EDLH1(I,J)*SBR(I,1,P)                                24
00460            WIPLE=WIPLE+WIPCH                                           26
00461             WIPBE=WIPBE+WIPCHB                                         26
00462            RATE=SDLR(1,1)                                              23
00463            CWIPCL=CWIPCL+DLH1(I,J)*SDLR(1,4)                           25,26
00464            CWIPCB=CWIPCB+DLH1(I,J)*SBR(I,1,1)                          25,26
00465            PRINT 59,L,I,JOB(I,J), EJOB(I,J),DLH1(I,J),WIPCH,WIPCHB     27
00466            GO TO 60                                                    21
00467        71  WIPCH=EDLH1(I,J)*SDLR(1,4)                                  23
00468            WIPCHB=EDLH1(I,J)*SBR(I,1,P)                                24
00469            WIPLE=WIPLE+WIPCH                                           26
00470             WIPBE=WIPBE+WIPCHB                                         26
00471            RATE=SDLR(1,4)                                              23
00472            CWIPCL=CWIPCL+DLH1(I,J)*SDLR(1,4)                           25,26
00473            CWIPCB=CWIPCB+DLH1(I,J)*SBR(I,1,1)                          25,26
00474            PRINT 59,L,I,JOB(I,J), EJOB(I,J),DLH1(I,J),WIPCH,WIPCHB     27
00475        60  CONTINUE                                                    21
00476            PRINT 53                                                    34
00477            PRINT 55                                                    34
00478            PRINT 56                                                    34
00479            PRINT57                                                     34
00480            PRINT 58                                                    34
```

```
00481            L=0                                                                                                  34
00482            LL=0                                                                                                 34
00483            DO 160 I=1,4                                                                                         28
00484            NI=NP(I)                                                                                             29
00485            DO 160 J=1,NI                                                                                        29
00486            L=L+1                                                                                                34
00487            LL=LL+1                                                                                              34
00488            P=CK2(I,J)                                                                                           30
00489            IF(LL.EQ.35) GO TO 172                                                                               34
00490            GO TO 173                                                                                            30
00491        172 PRINT 53                                                                                             34
00492            PRINT 55                                                                                             34
00493            PRINT 56                                                                                             34
00494            PRINT 57                                                                                             34
00495            PRINT 58                                                                                             34
00496            LL=0                                                                                                 34
00497            GO TO 173                                                                                            30
00498        173 RN11=RAN(0)                                                                                          30
00499            IF(RN11.LT..90) GO TO 171                                                                            30
00500            RN12=RAN(0)                                                                                          30
00501            IF(RN12.LT..50) GO TO 170                                                                            30
00502            WIPCH=EDLH2(I,J)*SDLR(2,2)                                                                           30
00503            WIPCHB=EDLH2(I,J)*SBR(I,2,P)                                                                         31
00504            WIPLE=WIPLE+WIPCH                                                                                    33
00505             WIPBE=WIPBE+WIPCHB                                                                                  33
00506            RATE=SDLR(2,2)                                                                                       30
00507            CWIPCL=CWIPCL+DLH2(I,J)*SDLR(2,4)                                                                    32
00508            CWIPCB=CWIPCB+DLH2(I,J)*SBR(I,2,1)                                                                   32
00509            PRINT 59,L,I,JOB(I,J),EEJOB(I,J),DLH2(I,J),WIPCH,WIPCHB                                              34
00510            GO TO 160                                                                                            28
00511        170 WIPCH=EDLH2(I,J)*SDLR(2,1)                                                                           30
00512            WIPCHB=EDLH2(I,J)*SBR(I,2,P)                                                                         31
00513            WIPLE=WIPLE+WIPCH                                                                                    33
00514             WIPBE=WIPBE+WIPCHB                                                                                  33
00515            RATE=SDLR(2,1)                                                                                       30
00516            CWIPCL=CWIPCL+DLH2(I,J)*SDLR(2,4)                                                                    32
00517            CWIPCB=CWIPCB+DLH2(I,J)*SBR(I,2,1)                                                                   32
```

```
00518          PRINT 59,L,I,JOB(I,J),EEJOB(I,J),DLH2(I,J),WIPCH,WIPCHB          34
00519          GO TO 160                                                        28
00520      171 WIPCH=EDLH2(I,J)*SDLR(2,4)                                       30
00521          WIPCHB=EDLH2(I,J)*SBR(I,2,P)                                     31
00522          WIPLE=WIPLE+WIPCH                                                33
00523           WIPBE=WIPBE+WIPCHB                                              33
00524          RATE=SDLR(2,4)                                                   30
00525          CWIPCL=CWIPCL+DLH2(I,J)*SDLR(2,4)                                32
00526          CWIPCB=CWIPCB+DLH2(I,J)*SBR(I,2,1)                               32
00527          PRINT 59,L,I,JOB(I,J),EEJOB(I,J),DLH2(I,J),WIPCH,WIPCHB          34
00528      160 CONTINUE                                                         28
00529          PRINT 216                                                        43
00530          PRINT 217                                                        43
00531          PRINT 218                                                        43
00532          PRINT 219                                                        43
00533          PRINT 220                                                        43
00534          FGMCH=0.0                                                        42
00535          K=0                                                              43
00536          L=0                                                              43
00537          DO221 I=1,4                                                      35
00538          NI=NP(I)                                                         36
00539          DO221 J=1,NI                                                     36
00540          MTUSE=JOB(I,J)                                                   37
00541          RMRE(I)=RMRE(I)+MTUSE                                            41
00542          MWIPC=EJOB(I,J)                                                  39
00543          MREQ=EJOB(I,J)                                                   38
00544          ERMRE(I)=ERMRE(I)+MREQ                                           41
00545          RN22=RAN(0)                                                      39
00546          IF(RN22.LT..10) GO TO 222                                        39
00547          SD(I,J)=PRAW(I,4)                                                39
00548          GO TO 223                                                        39
00549      222 SD(I,J)=PRAW(I,2)                                                39
00550      223 WIPCHM=MWIPC*SD(I,J)                                             42
00551          FGMCH=FGMCH+WIPCHM                                               42
00552          SUMAT1(I)=SUMAT1(I)+(MTUSE*PRAW(I,4))                            42
00553          SUMAT2(I)=SUMAT2(I)+(MREQ*SD(I,J))                               42
00554          K=K+1                                                            43
```

```
00555            L=L+1                                                          43
00556            IF(L.EQ.35) GO TO 224                                          43
00557            PRINT 225,K,I,MTUSE,MREQ,MWIPC,SD(I,J),WIPCHM,WIPCHM           43
00558            GO TO 221                                                      35
00559          224 PRINT 216                                                    43
00560            PRINT 217                                                      43
00561            PRINT 218                                                      43
00562            PRINT 219                                                      43
00563            PRINT 220                                                      43
00564            PRINT 225,K,I,MTUSE,MREQ,MWIPC,SD(I,J),WIPCHM,WIPCHM           43
00565            L=0                                                            43
00566          221 CONTINUE                                                     35
00567            DO233 I=1,4                                                    44
00568            TMTL(I)=TMTL(I)-SUMAT1(I)                                      46
00569            TGMTL(I)=TGMTL(I)-RMRE(I)                                      45
00570            ETMTL(I)=ETMTL(I)-SUMAT2(I)                                    46
00571            ETGMTL(I)=ETGMTL(I)-ERMRE(I)                                   45
00572          233 CONTINUE                                                     44
00573            DO234 I=1,4                                                    47
00574            FTMTL=FTMTL+TMTL(I)                                            48
00575            EFTMTL=EFTMTL+ETMTL(I)                                         48
00576          234 CONTINUE                                                     47
00577            DO 242 I=1,4                                                   62
00578            GWIP(I)=GWIP1(I)+GWIP2(I)                                      62
00579            EGWIP(I)=GWIP1(I)+GWIP2(I)                                     62
00580          242 CONTINUE                                                     62
00581            L=0                                                            60,68
00582            LL=0                                                           60,68
00583            PRINT 300                                                      60,68
00584            PRINT 301                                                      60,68
00585            PRINT 302                                                      60,68
00586            PRINT 303                                                      60,68
00587            PRINT 304                                                      60,68
00588            DO 269 I=1,4                                                   62
00589            NI=NP(I)                                                       62
00590            DO 269 J=1,NI                                                  62
00591            GWIP(I)=GWIP(I)+JCB(I,J)                                       62
```

```
00592          EGWIP(I)=EGWIP(I)+EEJOB(I,J)                                    62
00593      260 CONTINUE                                                        51
00594          TRIGER=0.0                                                      69
00595          DO 291 I=1,4                                                    49
00596          NI=NP(I)                                                        50
00597          DO 404 J=1,NI                                                   50
00598          IF(TRIGER.EQ.1.0) GO TO 281                                     69
00599          JOBC(I)=JOBC(I)+JCB(I,J)                                        69
00600          IF(JOBC(I).GE.TRAN(I)) GO TO 280                                69
00601          GO TO 281                                                       60,68
00602      280 ISPLIT(I)=JOBC(I)-TRAN(I)                                       69
00603          JCB(I,J)=JCB(I,J)-ISPLIT(I)                                     69
00604          EJCB(I,J)=EJCB(I,J)-ISPLIT(I)                                   69
00605          EEJCB(I,J)=EEJCB(I,J)-ISPLIT(I)                                 69
00606      281 L=L+1                                                           60,68
00607          LL=LL+1                                                         60,68
00608          IF(LL.EQ.35)GO TO 305                                           60,68
00609          IF(TRIGER.EQ.1.0) GO TO 400                                     69
00610          GO TO 308                                                       51
00611      305 PRINT300                                                        60,68
00612          PRINT 301                                                       60,68
00613          PRINT302                                                        60,68
00614          PRINT 303                                                       60,68
00615          PRINT 304                                                       60,68
00616          LL=0                                                            60,68
00617          IF(TRIGER.EQ.1.0) GO TO 400                                     69
00618      308 IF(EEJCB(I,J)-JCB(I,J).GT.20) GO TO  239                        51
00619          IFGC(I)=IFGC(I)+JCB(I,J)                                        61
00620          IFGCE(I)=IFGCE(I)+EEJOB(I,J)                                    61
00621          GWIP(I)=GWIP(I)-JCB(I,J)                                        62
00622          EGWIP(I)=EGWIP(I)-EEJOB(I,J)                                    62
00623          RN34=RAN(0)                                                     63
00624          IF(RN34.LT..08) GO TO  236                                      63
00625          P=1                                                             63
00626          GO TO  237                                                      63
00627      236 P=2                                                             63
00628      237 FGI(I)=FGI(I)+JOB(I,J)*STCP(I,1)                                64,65
```

```
00629            EFGI(I)=EFGI(I)+EEJCB(I,J)*STCP(I,P)                    65
00630            FG1=EEJCB(I,J)*STCP(I,P)                                63
00631            FG5=EEJCB(I,J)                                          63
00632            SUMAT1(I)=SUMAT1(I)-JOB(I,J)*STCPM(I,1)                 66
00633            CWIPCL=CWIPCL-JCB(I,J)*STCPL(I,1)                       66
00634            CWIPCB=CWIPCB-JOB(I,J)*STCPB(I,1)                       66
00635            FGMCH=FGMCH-EEJCB(I,J)*STCPM(I,P)                       67
00636            WIPBE=WIPBE-EEJOB(I,J)*STCPB(I,P)                       67
00637            WIPLE=WIPLE-EEJCB(I,J)*STCPL(I,P)                       67
00638            FG2=EEJCB(I,J)*STCPM(I,P)                               63
00639            FG3=EEJCB(I,J)*STCPL(I,P)                               63
00640            FG4=EEJCB(I,J)*STCPB(I,P)                               63
00641            GO TO 285                                               69
00642        239 ERROR=EEJOB(I,J)-JOB(I,J)                               52
00643            EJCB(I,J)=JOB(I,J)                                      52
00644            IFGO(I)=IFGO(I)+JCB(I,J)                                53
00645            IFGOE(I)=IFGOE(I)+ EJOB(I,J)                            53
00646            GWIP(I)=GWIP(I)-JCB(I,J)                                54
00647            EGWIP(I)=EGWIP(I)-EEJOB(I,J)                            54
00648            RN34=RAN(0)                                             55
00649            IF(RN34.LT..08) GO TO 243                               56
00650            P=1                                                     55
00651            GO TO 244                                               55
00652        243 P=2                                                     55
00653        244 FGI(I)=FGI(I)+JOB(I,J)*STCP(I,1)                        56,57
00654            EFGI(I)=EFGI(I)+EJCB(I,J)*STCP(I,P)                     57
00655            FG1=EJCB(I,J)*STCP(I,P)                                 55
00656            FG5=EJCB(I,J)                                           55
00657            SUMAT1(I)=SUMAT1(I)-JOB(I,J)*STCPM(I,1)                 58
00658            CWIPCL=CWIPCL-JCB(I,J)*STCPL(I,1)                       58
00659            CWIPCB=CWIPCB-JCB(I,J)*STCPB(I,1)                       58
00660            FGMCH=FGMCH-EEJCB(I,J)*STCPM(I,P)                       59
00661            WIPBE=WIPBE-EEJCB(I,J)*STCPB(I,P)                       59
00662            WIPLE=WIPLE-EEJCB(I,J)*STCPL(I,P)                       59
00663            FG2=EEJCB(I,J)*STCPM(I,P)                               55
00664            FG3=EEJCB(I,J)*STCPL(I,P)                               55
00665            FG4=EEJCB(I,J)*STCPB(I,P)                               55
```

```
00666        285 IF(JOBC(I).GE.TRAN(I)) TRIGER=1.0                          69
00667            IF(TRIGER.EQ.1.0) GO TO 282                                69
00668            GO TO 235                                                  60,68
00669        282 IF(FG5.LT.0.0) GO TO 400                                   60,68
00670            GO TO 235                                                  60,68
00671        400 PRINT 401,L,I                                              60,68
00672            GO TO 404                                                  69
00673        235 PRINT 306,L,I,JOB(I,J),FG5,FG1,FG2,FG3,FG4                 60,68
00674        404 CONTINUE                                                   69
00675        291 TRIGER=0.0                                                 69
00676            PRINT 226                                                  72
00677            PRINT 227                                                  72
00678            DO 228 I=1,4                                               72
00679            PRINT 229,I,ETQMTL(I),TQMTL(I)                             72
00680        228 CONTINUE                                                   72
00681            PRINT 261                                                  72
00682            DO 230 I=1,4                                               72
00683            PRINT 231,I,ETMTL(I),TMTL(I)                               72
00684        230 CONTINUE                                                   72
00685            PRINT 232,EFTMTL,FTMTL                                     72
00686            SUMA=0.0                                                   70
00687            PRINT 262                                                  72
00688            DO 264 I=1,4                                               70
00689            FG=FG+FGI(I)                                               70
00690            EFG=EFG+EFGI(I)                                            70
00691            SUMA=SUMA+SUMAT1(I)                                        71
00692            PRINT 263,I,EQWIP(I),QWIP(I)                               72
00693        264 CONTINUE                                                   72
00694            PRINT 265,FGMCH,SUMA                                       72
00695             PRINT 266,WIPLE,CWIPCL                                    72
00696            PRINT 267,WIPBE,CWIPCB                                     72
00697            TIPIE=FGMCH+WIPLE+WIPBE                                    71
00698            TWIPI=SUMA+CWIPCL+CWIPCB                                   71
00699            PRINT 268,TIPIE,TWIPI                                      72
00700             PRINT 271                                                 72
00701            DO 310 I=1,4                                               72
00702        310 PRINT 307,I,IFGQE(I),IFGQ(I)                               72
```

```
00703          PRINT 272,EFG,FG                                                    72
00704          CALL RGET(BASE)                                                     72
00705          PRINT 1000, BASE                                                    72
00706          STOP                                                                73
00707          END                                                                 73
00708          SUBROUTINE INVOIC                                                   5
00709          COMMON/ONE/RM(4,450),EX(4),STD(4),RAW(4),NO(4),J                    5
00710          K=1                                                                 5
00711          TOT1=0.0                                                            5
00712       11 RN1=RAN(0)                                                          5
00713          RN2=RAN(0)                                                          5
00714          X1=SQRT(-2.*ALOG(RN1))*COS(2.*3.14159*RN2)                          5
00715          M=X1*STD(J)+EX(J)                                                   5
00716          RM(J,K)=M                                                           5
00717          TOT2=TOT1+RM(J,K)                                                   5
00718          IF(TOT2.GE.RAW(J))GO TO 12                                          5
00719          TOT1=TOT2                                                           5
00720          K=K+1                                                               5
00721          GO TO 11                                                            5
00722       12 RM(J,K)=RAW(J) -TOT1                                                5
00723          NO(J)=K                                                             5
00724          RETURN                                                              5
00725          END                                                                 5
```

A P P E N D I X C

VARIABLE NAME DICTIONARY

VARIABLE NAME DICTIONARY

EXOGENOUS VARIABLES

* RM (J,K) = Units of the Jth raw material received by the company in the Kth shipment of the Jth raw material.

Where J=1...4, and K is bounded at its upper limit by the parameter RAW (J).

* JOB (I,J) = Units of the Ith product produced in relation to the Jth production order issued for the Ith product.

Where I=1...4, and J is bounded at its upper limit by the parameter WIP (I).

ENDOGENOUS VARIABLES

* CWIPCB = The burden-in-process account.

* CWIPCL = The direct labor-in-process account.

* DLH1 (I,J) = Allowable standard direct labor hours for Department I operations performed on the Jth production order issued for the Ith product.

Where I=1...4, and J is bounded at its upper limit by WIP (I).

* DLH2 (I,J) = Same as DLH1 except, DLH2 applies to Department II operations.

EDLH1 (I,J) = REPORTED allowable standard direct labor hours for Department I operations performed on the Jth production order issued for the Ith product.

Where I=1...4, and J is bounded at its upper limit by WIP (I).

EDLH2 (I,J) = Same as EDLH1 except, EDLH2 applies to Department II operations.

* Represents a control variable.

EEJOB (I,J) = REPORTED production count, entered on the job time ticket and production order by the machine operators in Department II. Production count EEJOB (I,J) applies specifically to the Jth production order issued for the Ith product.

Where I=1...4, and J is bounded at its upper limit by WIP (I).

EFG = REPORTED ending finished goods inventory; carried at full standard cost.

EFGI (I) = REPORTED finished goods inventory of the Ith product; carried at standard cost.

Where I=1...4.

EFTMTL = REPORTED combined ending raw materials inventory; carried at standard cost.

EJOB (I,J) = REPORTED production count, entered on the job time ticket and production order by the machine operators in Department I. Production count EJOB (I,J) applies specifically to the Jth production order issued for the Ith product.

Where I=1...4, and J is bounded at its upper limit by WIP (I).

EQWIP (I) = REPORTED units of the Ith product in the work-in-process inventory.

Where I=1...4.

ERM (J,K) = Units of the Jth raw material REPORTED as received in the Kth shipment of the Jth raw material.

Where J=1...4, and K is bounded at its upper limit by the parameter RAW (J).

ETMTL (I) = REPORTED inventory of the Ith raw material; carried at standard cost.

Where I=1...4.

ETQMTL (I) = REPORTED units of the Ith raw material included in the raw material inventory.

Where I=1...4.

* FG = The total ending inventory of finished goods; carried at full standard cost.

* FGI (I)	=	The finished goods inventory of the Ith product; carried at full standard cost. Where I=1...4.
FGMCH	=	REPORTED inventory of material-in-process; carried at standard cost.
FG1	=	For each production order transferred from work-in-process to finished goods inventory, FG1 represents the REPORTED charge to finished goods for the total standard cost of the units transferred.
FG2	=	For each production order transferred from work-in-process to finished goods inventory, FG2 represents the REPORTED credit to the material-in-process inventory for the total standard material cost of units transferred.
FG3	=	For each production order transferred from work-in-process to finished goods inventory, FG3 represents the REPORTED credit to labor-in-process for the total standard labor cost of the units transferred.
FG4	=	For each production order transferred from work-in-process to finished goods inventory, FG4 represents the REPORTED credit to burden-in-process for the total standard burden cost of the units transferred.
FG5	=	For each production order transferred from work-in-process to finished goods inventory, FG5 represents the REPORTED number of units transferred.
FTMTL	=	The total combined ending inventory of raw materials; carried at standard cost.
IFGQ (I)	=	The quantity of the Ith product included in the finished goods inventory. Where I=1...4.
IFGQE (I)	=	REPORTED units of the Ith product included in the finished goods inventory. Where I=1...4.
MREQ	=	REPORTED quantity of raw materials requisitioned in connection with any one production order.
MTUSE	=	The quantity of raw materials used in the manufacturing of any one production order.

MWIPC = REPORTED quantity of raw materials charged to work-in-process in connection with the manufacturing of any one production order.

QWIP (I) = The quantity of the Ith product included in the work-in-process inventory.

Where I=1...4.

SUMA = The ending material-in-process inventory; carried at standard cost.

SUMAT1 (I) = The material-in-process inventory for the Ith product; carried at standard cost.

Where I=1...4.

TIPIE = REPORTED combined ending work-in-process inventory; carried at standard cost. (Includes material, labor and burden-in-process.)

TMTL (I) = The inventory of the Ith raw material; carried at standard cost.

Where I=1...4.

TWIPI = The combined, ending, work-in-process inventory; carried at standard cost. (Includes material, labor and burden-in-process.)

WIPBE = REPORTED burden-in-process inventory; carried at standard cost.

WIPCH = REPORTED charge to direct labor-in-process at standard cost. The charge is calculated from the job time tickets issued for any one given production order.

WIPCHB = REPORTED charge to burden-in-process at standard cost. The charge is calculated from the job time tickets issued for any one given production order.

WIPCHM = REPORTED charge to material-in-process at standard cost. The charge is calculated from the material requisition issued for a given production order.

WIPLE = REPORTED direct labor-in-process inventory, carried at standard cost.

STATUS VARIABLES

BASE = An octal number which designates the point at which the computer pseudo-random number generator stopped at the end of the simulation.

CK1 (I,J,) = A switch set equal to 2 if errors occur in the costing of a Department I job time ticket applying to the Jth production order issued for the Ith product. If no costing error occurs, the switch is set equal to 1.

Where I=1...4, and J is bounded at its upper limit by the parameter WIP (I).

CK2 (I,J) = A switch which functions the same as CK1 (I,J) except CK2 (I,J) applies to job time tickets issued by Department II.

ERMRE (I) = REPORTED accumulated quantity of the Ith raw material, requisitioned during the period.

Where I=1...4.

ERROR = The amount of a production count error disclosed by the weigh counting procedure.

I = An index counter.

IN = A variable which takes on the value of other status variables including NO (J), NO (I) and NP (I). The value of IN places a limit on the number of various transactions generated by the model.

ISPLIT (I) = Units of Product I not transferred to finished goods along with other units of Product I contained in the same production order. ISPLIT (I) only applies to the last production order transferred to finished goods for the Ith product.

Where I=1...4.

J = An index counter.

JOBC (I) = A variable used to accumulate the number of units of the Ith product transferred from work-in-process to finished goods inventory. Production orders for the Ith product are chronologically transferred up to the point that JOBC (I) equals or exceeds the limiting parameter TRAN (I). TRAN (I) establishes the total units of Product I to be transferred during the period.

Where I=1...4.

K = An index counter.

L = An index counter.

LL = An index counter.

M = An index counter.

MISCOU = The amount of a quantity reporting error. The error may occur in checking in a shipment of raw material or it may occur in recording a production count.

NI = The same as IN. See IN for details.

NO (I) = An index counter which captures the index number representing the upper limit of an indexed series.

Where I=1...4.

NP (I) = Same as NO (I) described above.

P = A variable defined to be an integer in the computer model. P is used to indicate whether or not correct standard costs are to be applied to a given transaction. For all standard cost applications except direct labor rates; if P=1, correct standard costs are applied to the transaction. If P=2, however, incorrect standard costs are applied. In the case of the application of direct labor rates; if P=4, correct standard direct labor rates are applied. If P=1 or 2 erroneous rates are applied.

RMRE (I) = The quantity of the Ith raw material used in production during the period.

Where I=1...4.

RN1, RN2, RN5, RN7, RN8, RN9, RN10, RN11, RN12, RN21, RN22, RN34 = Uniformly distributed, pseudo-random numbers with values between 0 and 1. These numbers are generated from the C.D.C. 6600 RAN (0) random number generator.

SD (I,J) = The raw material standard cost applied to the Jth shipment of the Ith raw material.

Where I=1...4, and J is bounded at its upper limit by RAW (J).

SUMA 2 (I) = REPORTED total quantity of the Ith raw material requisitioned into production during the period at extended standard cost.

Where I=1...4.

TOT1 = An accumulator for total units of raw material shipped.

TOT2 = An accumulator for total units of raw material shipped.

TOT3 = An accumulator for total units of product manufactured.

TRIGGER = A switch which is used to stop the processing of production orders being transferred to finished goods inventory. If TRIGGER equals 0, production orders are transferred chronologically by product type. When the accumulated transferred units of the Ith product equals or exceeds TRAN (I), TRIGGER is re-set to 1 and transfers end on product I. The processing then proceeds to product type I+1 and TRIGGER is re-set to 0.

X1 = A normal deviate used in generating shipments of raw materials. Shipment sizes are assumed to follow a normal distribution with a given mean and standard deviation. The mean and standard deviation are established by the parameters EX (J) and STD (J) respectively.

X2 = A normal deviate used to generate production order quantities. Production order sizes are assumed to follow a normal distribution with a mean of 150 units and a standard deviation of 35 units.

PARAMETERS

EX (J) = The mean of the normal distribution used to generate individual shipments of the Jth raw material.

Where J=1...4.

PRAW (I,P) = The Pth standard cost for the Ith raw material. If p equals 1 PRAW (I,1) indicates the proper raw material standard. If p equals 2, PRAW (I,2) indicates an incorrect raw material standard by referencing a standard material cost for a similar type of raw material.

Where I=1...4, and P=1 or 2.

QWIP1 (I) = The quantity of the Ith product included in the initial beginning work-in-process inventory of Department I.

Where I=1...4.

QWIP2 (I) = The quantity of the Ith product included in the initial beginning work-in-process inventory of Department II.

Where I=1...4.

RAW (I) = Parameter establishing the total units of the Ith raw material to be shipped during the period.

Where I=1...4.

SBR (I,K,P) = The Pth burden rate for the Kth producing department applying to the Ith product.

Where I=1...4, K=1 or 2, and P=1 or 2.

SDLH (I,K,P) = The Pth direct labor hour standard for the Kth department applying to the Ith product.

Where I=1...4, K=1 or 2 and P=1 or 2.

STLR (K,P) = The Pth standard direct labor rate for the Kth department.

Where K=1 or 2 and P=1, 2, or 4.

STCP (I,P) = The Pth total unit standard cost of the Ith product.

Where I=1...4, and P=1 or 2.

STCPB (I,P) = The Pth burden unit standard cost for the Ith product.

Where I=1...4, and P=1 or 2.

STCPL (I,P) = The Pth direct labor unit standard cost for the Ith product.

Where I=1...4, and P=1 or 2.

STCPM (I,P) = The Pth material unit standard cost for the Ith product.

Where I=1...4, and P=1 or 2.

STD (J) = The standard deviation of the normal distribution used to generate individual shipments of the Jth raw material.

Where J=1...4.

TRAN (I) = The ACTUAL total quantity of the Ith product to be transferred from work-in-process to finished goods inventory during the period.

Where I=1...4.

WIP (I) = The ACTUAL total quantity of the Ith product to be produced during the period. WIP (I) sets the upper boundary on the individual production orders generated for the Ith product.

Where I=1...4.

OPERATING CHARACTERISTICS

f (ERROR) = There is no specified probability density function for the discovery of production count errors on production orders transferred from work-in-process to finished goods inventory. It is assumed that the weigh count operator discovers all errors on those production orders which are overstated by more than 20 units.

f (JOB) = The density function which determines the size of individual production orders. (Number of units actually produced.) Production order sizes are assumed to be normally distributed with a mean of 150 units and a standard deviation of 35 units.

f (MISCOU) = In the case of the receiving and inspection department, the probability density function, determining the occurrence of quantity count errors, is a discrete empirical distribution. Errors are specified to occur on 25 percent of the shipments received during the period. All shipments have an equal likelihood of being erroneously recorded. When an error occurs it is always assumed to be an understatement in the amount of 10 percent of the actual quantity shipped.

In the case of producing Department I, the probability density function, determining the occurrence of an error in recording the production count for a given production order, is a discrete empirical distribution. Errors are specified to occur on 15 percent of the production orders that are

processed in Department I during the period. All production orders processed have an equal likelihood of being erroneously recorded. Given that an error occurs in Department I, it is always assumed to be an overstatement of the production count. The amount of the overstatement is always 10 percent of the actual quantity produced on the order being processed.

In the case of producing Department II, the probability density function, determining the occurrence of an error in recording the production count for a given order, is also a discrete empirical distribution. The distribution for Department II depends upon the distribution specified for Department I. All production orders processed by Department II, which were erroneously reported by Department I are reported by Department II at the incorrect Department I count. In addition to these errors, Department II overstates the production count on 8 percent of the remaining production orders not erroneously reported by Department I. These orders are overstated by 5 percent of the actual quantity produced.

f (PRAW) = The probability density function determining the occurrence of an error in costing individual raw material shipments. The density function is a discrete empirical distribution. The distribution specifies that costing errors occur on 10 percent of the shipments processed during the period. All shipments have an equal likelihood of being erroneously priced. When an error occurs a standard cost for a raw material, similar to the one included in the shipment, is used to cost the shipment and update the raw material inventory. The erroneous standard cost may be greater or less than the correct standard cost depending upon the specific material involved.

f (SDLH, SBR) = The probability density function which determines the occurrence of an error in applying direct labor and burden rate standards. This probability density function is an empirical discrete distribution. The distribution specifies that costing errors occur on 8 percent of the job-time-tickets prepared by Department I and Department II. All job-time-tickets processed have an equal likelihood of being erroneously costed. When an error occurs, standards for a product similar to the product involved are applied to the job ticket being processed. Erroneous standards may result in extended

charges to labor and burden-in-process greater or less than those that would result if correct standards were applied.

f (SDLR) = The probability density function which determines the occurrence of an error in applying standard direct labor rates to job-time-tickets prepared by Departments I and II. This probability density function is an empirical discrete distribution. The distribution specifies that errors occur on the costing of 10 percent of the job-time-tickets processed. All job tickets processed have an equal likelihood of being erroneously costed. When an error occurs, 50 percent of them result in the application of an obsolete direct labor rate. The other 50 percent of the errors result in the application of a rate applicable to an incorrect Department.

f (STCP, STCPL, STCPB, STCPM) = The probability density function which determines the occurrence of an error in applying standard unit costs to production orders transferred from work-in-process to finished goods inventory. This probability function is an empirical discrete distribution. The distribution specifies that errors occur in the costing of 8 percent of the production orders transferred during the period. Each production order transferred has an equal likelihood of being erroneously priced. When an error occurs unit standard costs for an incorrect similar product are applied to the production order being processed.

A P P E N D I X D

SAMPLES OF THE DATA PRINTED

BY THE SYSTEM SIMULATION PROGRAM

SUMMARY OF SHIPMENTS RECEIVED AND RECEIVING REPORTS PROCESSED IN TERMS OF UNITS

SHIPMENT NUMBER	TYPE OF MATERIAL	QUANTITY SHIPPED	RECEIVER NUMBER	TYPE OF MATERIAL	QUANTITY RECEIVED
1	1	153.0	1	1	153.0
2	1	204.0	2	1	184.0
3	1	211.0	3	1	211.0
4	1	179.0	4	1	162.0
5	1	195.0	5	1	176.0
6	1	208.0	6	1	208.0
7	1	200.0	7	1	200.0
8	1	195.0	8	1	176.0
9	1	237.0	9	1	237.0
10	1	217.0	10	1	196.0
11	1	218.0	11	1	218.0
12	1	200.0	12	1	200.0
13	1	238.0	13	1	238.0
14	1	191.0	14	1	191.0
15	1	169.0	15	1	153.0
16	1	229.0	16	1	229.0
17	1	212.0	17	1	191.0
18	1	228.0	18	1	228.0
19	1	172.0	19	1	172.0
20	1	215.0	20	1	215.0
21	1	246.0	21	1	246.0
22	1	129.0	22	1	129.0
23	1	169.0	23	1	169.0
24	1	226.0	24	1	226.0
25	1	197.0	25	1	197.0
26	1	185.0	26	1	185.0
27	1	166.0	27	1	150.0
28	1	191.0	28	1	191.0
29	1	168.0	29	1	152.0
30	1	221.0	30	1	199.0
31	1	255.0	31	1	255.0
32	1	210.0	32	1	210.0
33	1	193.0	33	1	174.0
34	1	141.0	34	1	141.0

SUMMARY OF SHIPMENTS RECEIVED AND RECEIVING REPORTS PROCESSED IN TERMS OF UNITS

SHIPMENT NUMBER	TYPE OF MATERIAL	QUANTITY SHIPPED	RECEIVER NUMBER	TYPE OF MATERIAL	QUANTITY RECEIVED
175	1	247.0	175	1	247.0
176	1	167.0	176	1	167.0
177	1	196.0	177	1	196.0
178	1	221.0	178	1	221.0
179	1	214.0	179	1	214.0
180	1	206.0	180	1	206.0
181	1	188.0	181	1	170.0
182	1	216.0	182	1	216.0
183	1	156.0	183	1	141.0
184	1	177.0	184	1	177.0
185	1	228.0	185	1	228.0
186	1	220.0	186	1	220.0
187	1	234.0	187	1	234.0
188	1	202.0	188	1	202.0
189	1	194.0	189	1	194.0
190	1	191.0	190	1	191.0
191	1	233.0	191	1	233.0
192	1	228.0	192	1	228.0
193	1	174.0	193	1	157.0
194	1	237.0	194	1	237.0
195	1	195.0	195	1	195.0
196	1	240.0	196	1	240.0
197	1	185.0	197	1	185.0
198	1	223.0	198	1	229.0
199	1	180.0	199	1	180.0
200	1	207.0	200	1	207.0
201	1	43.0	201	1	43.0
202	2	192.0	202	2	192.0
203	2	173.0	203	2	173.0
204	2	153.0	204	2	153.0
205	2	171.0	205	2	171.0
206	2	210.0	206	2	210.0
207	2	211.0	207	2	211.0
208	2	195.0	208	2	195.0
209	2	259.0	209	2	234.0

SUMMARY OF SHIPMENTS RECEIVED AND RECEIVING FORMS PROCESSED
PRICED AND EXTENDED AT STANDARD COST

SHIPMENT NUMBER	EXTENDED STD.COST	RECEIVER NUMBER	EXTENDED STD.COST
1	2065.50	1	994.50
2	2754.00	2	2484.00
3	2848.50	3	2848.50
4	2416.50	4	2187.00
5	2632.50	5	2376.00
6	2808.00	6	1352.00
7	2700.00	7	1300.00
8	2632.50	8	2376.00
9	3199.50	9	3199.50
10	2929.50	10	2646.00
11	2943.00	11	2943.00
12	2700.00	12	1300.00
13	3213.00	13	3213.00
14	2578.50	14	2578.50
15	2281.50	15	2065.50
16	3091.50	16	3091.50
17	2862.00	17	2578.50
18	3078.00	18	3078.00
19	2322.00	19	2322.00
20	2902.50	20	2902.50
21	3321.00	21	1599.00
22	1741.50	22	1741.50
23	2281.50	23	2281.50
24	3051.00	24	3051.00
25	2659.50	25	2659.50
26	2497.50	26	2497.50
27	2241.00	27	2025.00
28	2578.50	28	2578.50
29	2268.00	29	2052.00
30	2983.50	30	2686.50
31	3442.50	31	3442.50
32	2835.00	32	2835.00
33	2605.50	33	2349.00
34	1903.50	34	1903.50

SUMMARY OF SHIPMENTS RECEIVED AND RECEIVING FORMS PROCESSED
PRICED AND EXTENDED AT STANDARD COST

SHIPMENT NUMBER	EXTENDED STD.COST	RECEIVER NUMBER	EXTENDED STD.COST
175	3334.50	175	3334.50
176	2254.50	176	2254.50
177	2646.00	177	2646.00
178	2983.50	178	2983.50
179	2889.00	179	2889.00
180	2781.00	180	2781.00
181	2538.00	181	2295.00
182	2916.00	182	2916.00
183	2106.00	183	1903.50
184	2389.50	184	2389.50
185	3078.00	185	3078.00
186	2970.00	186	2970.00
187	3159.00	187	3159.00
188	2727.00	188	2727.00
189	2619.00	189	1261.00
190	2578.50	190	2578.50
191	3145.50	191	3145.50
192	3078.00	192	3078.00
193	2349.00	193	2119.50
194	3199.50	194	3199.50
195	2632.50	195	2632.50
196	3240.00	196	3240.00
197	2497.50	197	2497.50
198	3010.50	198	3010.50
199	2430.00	199	2430.00
200	2794.50	200	2794.50
201	580.50	201	580.50
202	3206.40	202	1536.00
203	2889.10	203	2889.10
204	2555.10	204	2555.10
205	2855.70	205	2855.70
206	3507.00	206	3507.00
207	3523.70	207	3523.70
208	3256.50	208	3256.50
209	4325.30	209	3907.80

PRODUCTION ORDER SUMMARY FOR THE PERIOD FOR DEPARTMENT 1

ORDER NO.	PRODUCT	UNITS PRODUCED	UNITS REPORTED	DIRECT LBR. HRS.REPORTED	DIR.LBR.CHARGED WORK-IN-PROCESS	BURDEN CHARGED WORK-IN-PROCESS
1	1	187.	187.	11.22000	69.56	144.18
2	1	187.	187.	11.22000	69.56	144.18
3	1	196.	196.	11.76000	72.91	151.12
4	1	131.	144.	7.86000	53.57	111.02
5	1	156.	156.	9.36000	58.03	120.28
6	1	172.	172.	10.32000	63.98	132.61
7	1	118.	118.	7.08000	43.90	90.98
8	1	76.	76.	4.56000	18.85	34.66
9	1	183.	183.	10.98000	68.08	141.09
10	1	134.	134.	8.04000	49.85	103.31
11	1	205.	205.	12.30000	76.26	158.05
12	1	68.	68.	4.08000	25.30	52.43
13	1	121.	121.	7.26000	45.01	93.29
14	1	98.	107.	5.88000	39.80	82.50
15	1	113.	113.	6.78000	42.04	87.12
16	1	179.	196.	10.74000	72.91	151.12
17	1	126.	126.	7.56000	46.87	97.15
18	1	68.	74.	4.08000	18.35	33.74
19	1	94.	94.	5.64000	34.97	72.47
20	1	68.	68.	4.08000	25.30	52.43
21	1	166.	166.	9.96000	61.75	127.99
22	1	142.	142.	8.52000	52.82	109.48
23	1	131.	131.	7.86000	47.16	101.00
24	1	108.	108.	6.48000	40.18	83.27
25	1	124.	124.	7.44000	44.64	95.60
26	1	151.	151.	9.06000	56.17	116.42
27	1	136.	136.	8.16000	50.59	104.86
28	1	155.	155.	9.30000	55.80	119.50
29	1	154.	154.	9.24000	55.44	118.73
30	1	173.	173.	10.38000	64.36	133.38
31	1	147.	147.	8.82000	54.68	113.34
32	1	95.	95.	5.70000	35.34	73.24
33	1	153.	153.	9.18000	56.92	117.96
34	1	118.	118.	7.08000	43.90	90.98

PRODUCTION ORDER SUMMARY FOR THE PERIOD FOR DEPARTMENT 1

ORDER NO.	PRODUCT	UNITS PRODUCED	UNITS REPORTED	DIRECT LBR. HRS.REPORTED	DIR.LBR.CHARGED WORK-IN-PROCESS	BURDEN CHARGED WORK-IN-PROCESS
210	1	141.	141.	8.46000	52.45	108.71
211	1	153.	153.	9.18000	56.92	117.96
212	1	143.	143.	8.58000	53.20	110.25
213	1	168.	184.	10.08000	68.45	141.86
214	1	153.	153.	9.18000	56.92	117.96
215	1	186.	186.	11.16000	66.96	143.41
216	1	131.	131.	7.86000	48.73	101.00
217	1	214.	235.	12.84000	87.42	181.18
218	1	202.	202.	12.12000	75.14	155.74
219	1	116.	127.	6.96000	47.24	97.92
220	1	197.	197.	11.82000	48.86	89.83
221	1	102.	102.	6.12000	37.94	78.64
222	1	123.	123.	7.38000	45.76	94.83
223	1	123.	135.	7.38000	50.22	104.08
224	1	74.	74.	4.44000	27.53	57.05
225	1	186.	186.	11.16000	69.19	143.41
226	1	117.	117.	7.02000	43.52	90.21
227	1	36.	36.	2.16000	13.39	27.76
228	2	143.	143.	12.87000	79.79	165.38
229	2	172.	189.	15.48000	95.26	218.58
230	2	123.	123.	11.07000	68.63	142.25
231	2	94.	94.	8.46000	52.45	108.71
232	2	138.	138.	12.42000	77.00	159.60
233	2	160.	160.	14.40000	89.28	185.04
234	2	95.	95.	8.55000	53.01	109.87
235	2	129.	129.	11.61000	71.98	149.19
236	2	190.	190.	17.10000	106.02	219.73
237	2	142.	142.	12.78000	79.24	164.22
238	2	183.	183.	16.47000	102.11	211.64
239	2	82.	82.	7.38000	41.33	94.83
240	2	203.	203.	18.27000	113.27	234.77
241	2	169.	169.	15.21000	94.30	195.45
242	2	148.	148.	13.32000	82.58	171.16
243	2	120.	120.	10.80000	66.96	138.78
244	2	168.	168.	15.12000	93.74	194.29

PRODUCTION ORDER SUMMARY FOR THE PERICD FOR DEPARTMENT 2

ORDER NO.	PRODUCT	UNITS PRODUCED	UNITS REPORTED	DIRECT LBR. HRS.REPORTED	DIR.LBR.CHARGED WORK-IN-PROCESS	BURDEN CHARGED WORK-IN-PROCESS
1	1	187.	187.	7.48000	41.89	385.59
2	1	187.	187.	7.48000	41.89	385.59
3	1	196.	196.	7.84000	43.90	404.15
4	1	131.	144.	5.24000	32.26	296.93
5	1	156.	156.	6.24000	34.94	321.67
6	1	172.	172.	6.88000	38.53	354.66
7	1	118.	118.	4.72000	26.43	243.32
8	1	76.	76.	3.04000	17.02	156.71
9	1	183.	183.	7.32000	40.99	377.35
10	1	134.	140.	5.36000	31.36	246.68
11	1	205.	205.	8.20000	45.92	422.71
12	1	68.	68.	2.72000	15.23	140.22
13	1	121.	121.	4.84000	27.10	249.50
14	1	98.	107.	3.92000	23.97	188.53
15	1	113.	113.	4.52000	25.31	233.01
16	1	179.	196.	7.16000	43.90	404.15
17	1	126.	132.	5.04000	29.57	272.18
18	1	68.	74.	2.72000	16.58	152.59
19	1	94.	94.	3.76000	21.06	193.83
20	1	68.	68.	2.72000	15.23	140.22
21	1	166.	166.	6.64000	37.18	342.29
22	1	142.	142.	5.68000	30.67	292.80
23	1	131.	131.	5.24000	29.34	230.82
24	1	108.	108.	4.32000	24.19	190.30
25	1	124.	124.	4.96000	30.75	218.49
26	1	151.	151.	6.04000	33.82	266.06
27	1	136.	136.	5.44000	30.46	280.43
28	1	155.	155.	6.20000	34.72	319.61
29	1	154.	154.	6.16000	34.50	317.55
30	1	173.	173.	6.92000	38.75	356.73
31	1	147.	147.	5.88000	32.93	303.11
32	1	95.	95.	3.80000	21.28	195.89
33	1	153.	153.	6.12000	37.94	315.49
34	1	118.	118.	4.72000	26.43	243.32

PRODUCTION ORDER SUMMARY FOR THE PERIOD FOR DEPARTMENT 2

ORDER NO.	PRODUCT	UNITS PRODUCED	UNITS REPORTED	DIRECT LBR. HRS.REPORTED	DIR.LBR.CHARGED WORK-IN-PROCESS	BURDEN CHARGED WORK-IN-PROCESS
210	1	141.	141.	5.64000	31.58	290.74
211	1	153.	153.	6.12000	34.27	315.49
212	1	143.	150.	5.72000	33.60	309.30
213	1	168.	184.	6.72000	41.22	379.41
214	1	153.	153.	6.12000	34.27	315.49
215	1	186.	195.	7.44000	43.68	402.09
216	1	131.	131.	5.24000	29.34	230.82
217	1	214.	235.	8.56000	52.64	484.57
218	1	202.	202.	8.08000	45.25	416.52
219	1	116.	127.	4.64000	28.45	261.87
220	1	197.	197.	7.88000	44.13	406.21
221	1	102.	102.	4.08000	22.85	210.32
222	1	123.	123.	4.92000	27.55	253.63
223	1	123.	135.	4.92000	29.16	278.37
224	1	74.	74.	2.96000	15.98	152.59
225	1	186.	186.	7.44000	41.66	327.73
226	1	117.	117.	4.68000	26.21	241.25
227	1	35.	36.	1.44000	8.06	74.23
228	2	143.	143.	8.58000	48.05	442.30
229	2	172.	189.	10.32000	63.50	584.58
230	2	123.	123.	7.38000	45.76	380.44
231	2	94.	98.	5.64000	32.93	303.11
232	2	138.	138.	8.28000	46.37	426.83
233	2	160.	160.	9.60000	53.76	494.88
234	2	95.	95.	5.70000	31.92	293.83
235	2	129.	129.	7.74000	50.57	397.77
236	2	190.	190.	11.40000	63.84	587.67
237	2	142.	142.	8.52000	47.71	439.21
238	2	183.	183.	10.98000	61.49	566.02
239	2	82.	86.	4.92000	28.90	266.00
240	2	203.	203.	12.18000	68.21	627.88
241	2	169.	169.	10.14000	56.78	522.72
242	2	148.	148.	8.88000	49.73	457.76
243	2	120.	120.	7.20000	40.32	371.16
244	2	168.	168.	10.08000	56.45	519.62

MATERIAL REQUISITION SUMMARY

REQUISITION NUMBER	TYPE OF MATERIAL	QUANTITY USED	QUANTITY REQUISITIONED	CHARGED TO WORK-IN-PROCESS QUANTITY	STANDARD	AMOUNT	AMOUNT CREDITED RAW MATERIALS
1	1	187	187	187	13.50	2524.50	2524.50
2	1	187	187	187	13.50	2524.50	2524.50
3	1	196	196	196	13.50	2646.00	2646.00
4	1	131	144	144	13.50	1944.00	1944.00
5	1	156	156	156	13.50	2106.00	2106.00
6	1	172	172	172	13.50	2322.00	2322.00
7	1	118	118	118	13.50	1593.00	1593.00
8	1	76	76	76	13.50	1026.00	1026.00
9	1	183	183	183	13.50	2470.50	2470.50
10	1	134	134	134	13.50	1809.00	1809.00
11	1	205	205	205	13.50	2767.50	2767.50
12	1	68	68	68	13.50	918.00	918.00
13	1	121	121	121	13.50	1633.50	1633.50
14	1	98	107	107	13.50	1444.50	1444.50
15	1	113	113	113	13.50	1525.50	1525.50
16	1	179	196	196	13.50	2646.00	2646.00
17	1	126	126	126	13.50	1701.00	1701.00
18	1	68	74	74	13.50	999.00	999.00
19	1	94	94	94	13.50	1269.00	1269.00
20	1	68	68	68	13.50	918.00	918.00
21	1	166	166	166	13.50	2241.00	2241.00
22	1	142	142	142	13.50	1917.00	1917.00
23	1	131	131	131	13.50	1768.50	1768.50
24	1	108	108	108	13.50	1458.00	1458.00
25	1	124	124	124	13.50	1674.00	1674.00
26	1	151	151	151	13.50	2038.50	2038.50
27	1	136	136	136	13.50	1836.00	1836.00
28	1	155	155	155	13.50	2092.50	2092.50
29	1	154	154	154	13.50	2079.00	2079.00
30	1	173	173	173	13.50	2335.50	2335.50
31	1	147	147	147	13.50	1984.50	1984.50
32	1	95	95	95	13.50	1282.50	1282.50
33	1	153	153	153	13.50	2065.50	2065.50
34	1	118	118	118	13.50	1593.00	1593.00

MATERIAL REQUISITION SUMMARY

REQUISITION NUMBER	TYPE OF MATERIAL	QUANTITY USED	QUANTITY REQUISITIONED	CHARGED TO WORK-IN-PROCESS QUANTITY	STANDARD	AMOUNT	AMOUNT CREDITED RAW MATERIALS
210	1	141	141	141	6.50	916.50	916.50
211	1	153	153	153	13.50	2065.50	2065.50
212	1	143	143	143	13.50	1930.50	1930.50
213	1	168	184	184	13.50	2484.00	2484.00
214	1	153	153	153	13.50	2065.50	2065.50
215	1	186	186	186	6.50	1209.00	1209.00
216	1	131	131	131	13.50	1768.50	1768.50
217	1	214	235	235	13.50	3172.50	3172.50
218	1	202	202	202	13.50	2727.00	2727.00
219	1	116	127	127	13.50	1714.50	1714.50
220	1	197	197	197	13.50	2659.50	2659.50
221	1	102	102	102	6.50	663.00	663.00
222	1	123	123	123	13.50	1660.50	1660.50
223	1	123	135	135	13.50	1822.50	1822.50
224	1	74	74	74	13.50	999.00	999.00
225	1	186	186	186	13.50	2511.00	2511.00
226	1	117	117	117	6.50	760.50	760.50
227	1	36	36	36	13.50	486.00	486.00
228	2	143	143	143	16.70	2388.10	2388.10
229	2	172	189	189	8.00	1512.00	1512.00
230	2	123	123	123	8.00	984.00	984.00
231	2	94	94	94	16.70	1569.80	1569.80
232	2	138	138	138	16.70	2304.60	2304.60
233	2	160	160	160	16.70	2672.00	2672.00
234	2	95	95	95	16.70	1586.50	1586.50
235	2	129	129	129	16.70	2154.30	2154.30
236	2	190	190	190	16.70	3173.00	3173.00
237	2	142	142	142	16.70	2371.40	2371.40
238	2	183	183	183	16.70	3056.10	3056.10
239	2	82	82	82	16.70	1369.40	1369.40
240	2	203	203	203	16.70	3390.10	3390.10
241	2	169	169	169	16.70	2822.30	2822.30
242	2	148	148	148	8.00	1184.00	1184.00
243	2	120	120	120	16.70	2004.00	2004.00
244	2	168	168	168	16.70	2805.60	2805.60

SUMMARY OF PRODUCTION ORDERS TRANSFERRED TO FINISHED GOODS

ORDER NO.	PROD.	UNITS TRANS.	UNITS REPORTED AS TRANSFERRED	EXTENDED CHARGE FINISHED GOODS	EXTENDED CREDIT TO W.I.P. MATERIAL	LABOR	BURDEN
1	1	187.	187.	3165.72	2524.50	111.45	529.77
2	1	187.	187.	3165.72	2524.50	111.45	529.77
3	1	196.	196.	3318.08	2646.00	116.82	555.27
4	1	131.	144.	2437.78	1944.00	85.82	407.95
5	1	156.	156.	2640.92	2106.00	92.98	441.95
6	1	172.	172.	2911.79	2322.00	102.51	487.28
7	1	118.	118.	1997.62	1593.00	70.33	334.29
8	1	76.	76.	1286.60	1026.00	45.30	215.31
9	1	183.	183.	3098.01	2470.50	109.07	518.44
10	1	134.	140.	2370.06	1890.00	83.44	396.62
11	1	205.	205.	1883.95	1332.50	96.76	454.69
12	1	68.	68.	1151.17	918.00	40.53	192.64
13	1	121.	121.	2048.41	1633.50	72.12	342.79
14	1	98.	107.	1811.40	1444.50	63.77	303.13
15	1	113.	113.	1912.98	1525.50	67.35	320.13
16	1	179.	196.	3318.08	2646.00	116.82	555.27
17	1	126.	132.	2234.63	1782.00	78.67	373.96
18	1	68.	74.	1252.75	999.00	44.10	209.64
19	1	94.	94.	1591.33	1269.00	56.02	266.30
20	1	68.	68.	1151.17	918.00	40.53	192.64
21	1	166.	166.	2810.21	2241.00	98.94	470.28
22	1	142.	142.	2403.92	1917.00	84.63	402.29
23	1	131.	131.	2217.70	1768.50	78.08	371.12
24	1	108.	108.	1328.33	1458.00	64.37	305.96
25	1	124.	124.	2099.20	1674.00	73.90	351.29
26	1	151.	151.	2556.28	2038.50	90.00	427.78
27	1	136.	136.	2302.34	1836.00	81.06	385.29
28	1	155.	155.	2623.99	2092.50	92.38	439.11
29	1	154.	154.	2607.07	2079.00	91.78	436.28
30	1	173.	173.	2928.72	2335.50	103.11	490.11
31	1	147.	147.	2488.56	1984.50	87.61	416.45
32	1	95.	95.	873.05	617.50	44.84	210.71
33	1	153.	153.	2590.14	2065.50	91.19	433.45
34	1	118.	118.	1997.62	1593.00	70.33	334.29

SUMMARY OF PRODUCTION ORDERS TRANSFERRED TO FINISHED GOODS

ORDER NO.	PROD.	UNITS TRANS.	UNITS REPORTED AS TRANSFERRED	EXTENDED CHARGE FINISHED GOODS	EXTENDED CREDIT TO W.I.P. MATERIAL	LABOR	BURDEN
210	1	ORDER NOT TRANSFERRED DURING THE PERIOD					
211	1	ORDER NOT TRANSFERRED DURING THE PERIOD					
212	1	ORDER NOT TRANSFERRED DURING THE PERIOD					
213	1	ORDER NOT TRANSFERRED DURING THE PERIOD					
214	1	ORDER NOT TRANSFERRED DURING THE PERIOD					
215	1	ORDER NOT TRANSFERRED DURING THE PERIOD					
216	1	ORDER NOT TRANSFERRED DURING THE PERIOD					
217	1	ORDER NOT TRANSFERRED DURING THE PERIOD					
218	1	ORDER NOT TRANSFERRED DURING THE PERIOD					
219	1	ORDER NOT TRANSFERRED DURING THE PERIOD					
220	1	ORDER NOT TRANSFERRED DURING THE PERIOD					
221	1	ORDER NOT TRANSFERRED DURING THE PERIOD					
222	1	ORDER NOT TRANSFERRED DURING THE PERIOD					
223	1	ORDER NOT TRANSFERRED DURING THE PERIOD					
224	1	ORDER NOT TRANSFERRED DURING THE PERIOD					
225	1	ORDER NOT TRANSFERRED DURING THE PERIOD					
226	1	ORDER NOT TRANSFERRED DURING THE PERIOD					
227	1	ORDER NOT TRANSFERRED DURING THE PERIOD					
228	2	143.	143.	3123.62	2388.10	127.84	607.68
229	2	172.	189.	4128.42	3156.30	168.97	803.16
230	2	123.	123.	2686.75	2054.10	109.96	522.69
231	2	94.	98.	2140.66	1636.60	87.61	416.45
232	2	138.	138.	3014.40	2304.60	123.37	586.43
233	2	160.	160.	3494.96	2672.00	143.04	679.92
234	2	95.	95.	2075.13	1586.50	84.93	403.70
235	2	129.	129.	2817.81	2154.30	115.33	548.19
236	2	190.	190.	2380.98	1520.00	145.16	715.82
237	2	142.	142.	3101.78	2371.40	126.95	603.43
238	2	183.	183.	3997.36	3056.10	163.60	777.66
239	2	82.	86.	1879.54	1436.20	76.88	365.46
240	2	203.	203.	4434.23	3390.10	181.48	862.65
241	2	169.	169.	3691.55	2822.30	151.09	718.17
242	2	148.	148.	3232.84	2471.60	132.31	628.93
243	2	120.	120.	2621.22	2004.00	107.28	509.94
244	2	168.	166.	3669.71	2805.60	150.19	713.92

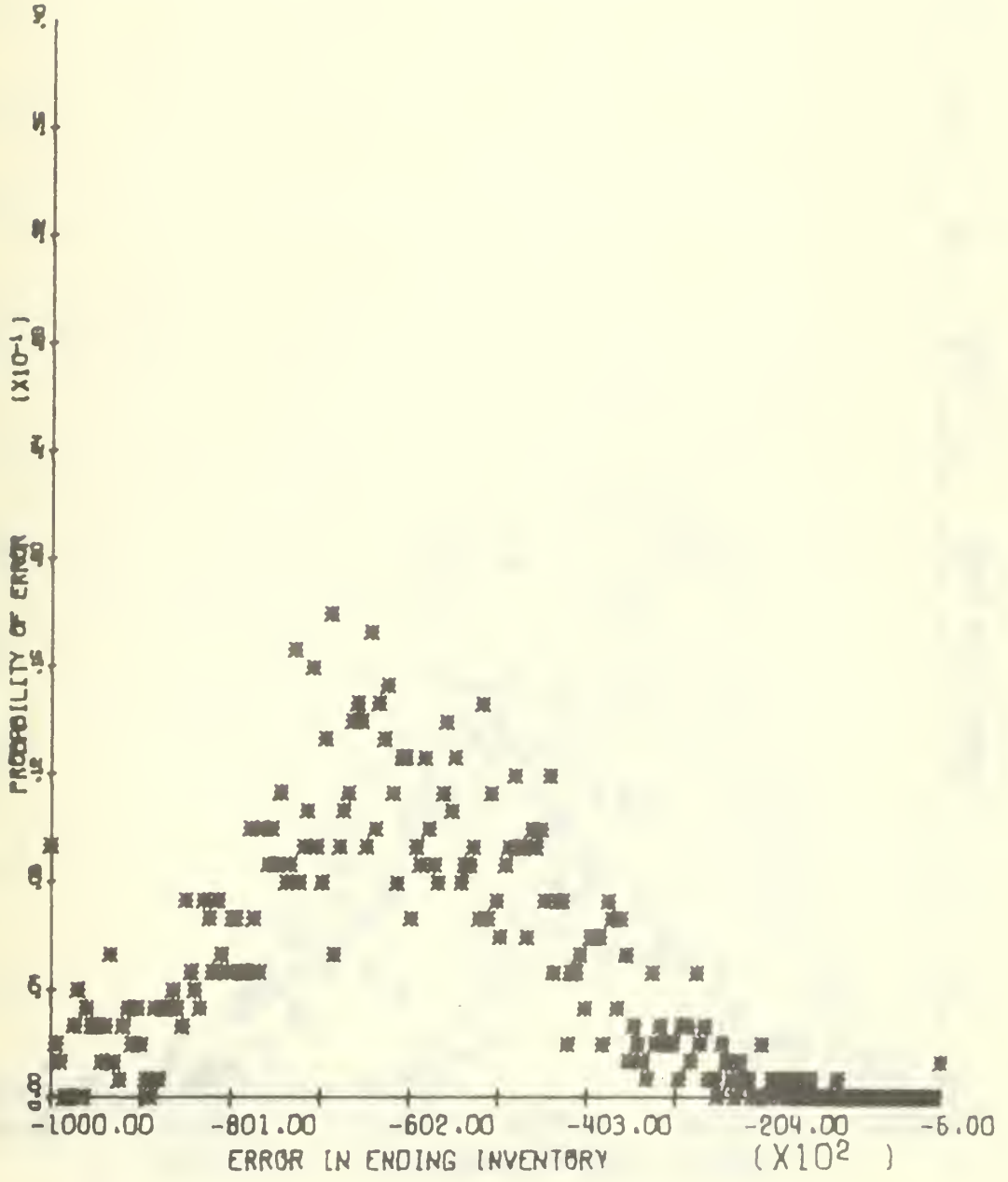
FINAL SUMMARY REPORT

RAW MATERIALS ENDING INVENTORY	REPORTED	CONTROL
UNITS OF RAW MATERIAL 1	12991.00	14400.00
UNITS OF RAW MATERIAL 2	7716.00	9000.00
UNITS OF RAW MATERIAL 3	6612.00	8000.00
UNITS OF RAW MATERIAL 4	8674.00	9600.00
STD.COST OF RAW MATERIAL 1 INVENTORY	185948.50	194400.00
STD.COST OF RAW MATERIAL 2 INVENTORY	120383.40	150300.00
STD.COST OF RAW MATERIAL 3 INVENTORY	32492.00	52000.00
STD.COST OF RAW MATERIAL 4 INVENTORY	70914.50	76800.00
TOTAL STD.COST OF RAW MATERIAL INVENTORY	409738.40	473500.00

WORK-IN-PROCESS ENDING INVENTORY	REPORTED	CONTROL
UNITS OF PRODUCT 1	3402.00	3320.00
UNITS OF PRODUCT 2	2086.00	2036.00
UNITS OF PRODUCT 3	3295.00	3223.00
UNITS OF PRODUCT 4	7284.00	7181.00
STD.COST OF MATERIAL-IN-PROCESS	154734.10	157218.70
STD.COST OF LABOR-IN-PROCESS	10425.84	10806.44
STD.BURDEN CONTENT OF WORK-IN-PROCESS	52710.13	52260.57
TOTAL STD.COST OF WORK-IN-PROCESS	217870.07	220285.72

FINISHED GOODS ENDING INVENTORY	REPORTED	CONTROL
UNITS OF PRODUCT 1	4238.00	3680.00
UNITS OF PRODUCT 2	4909.00	4464.00
UNITS OF PRODUCT 3	7241.00	6777.00
UNITS OF PRODUCT 4	5483.00	5219.00
TOTAL STD.COST OF FINISHED GOODS	299668.73	287490.63

PLOT OF THE PROBABILITY DISTRIBUTION OF THE ERROR IN THE RAW MATERIALS INVENTORY COMPUTED BY THE SYSTEM SIMULATION MODEL

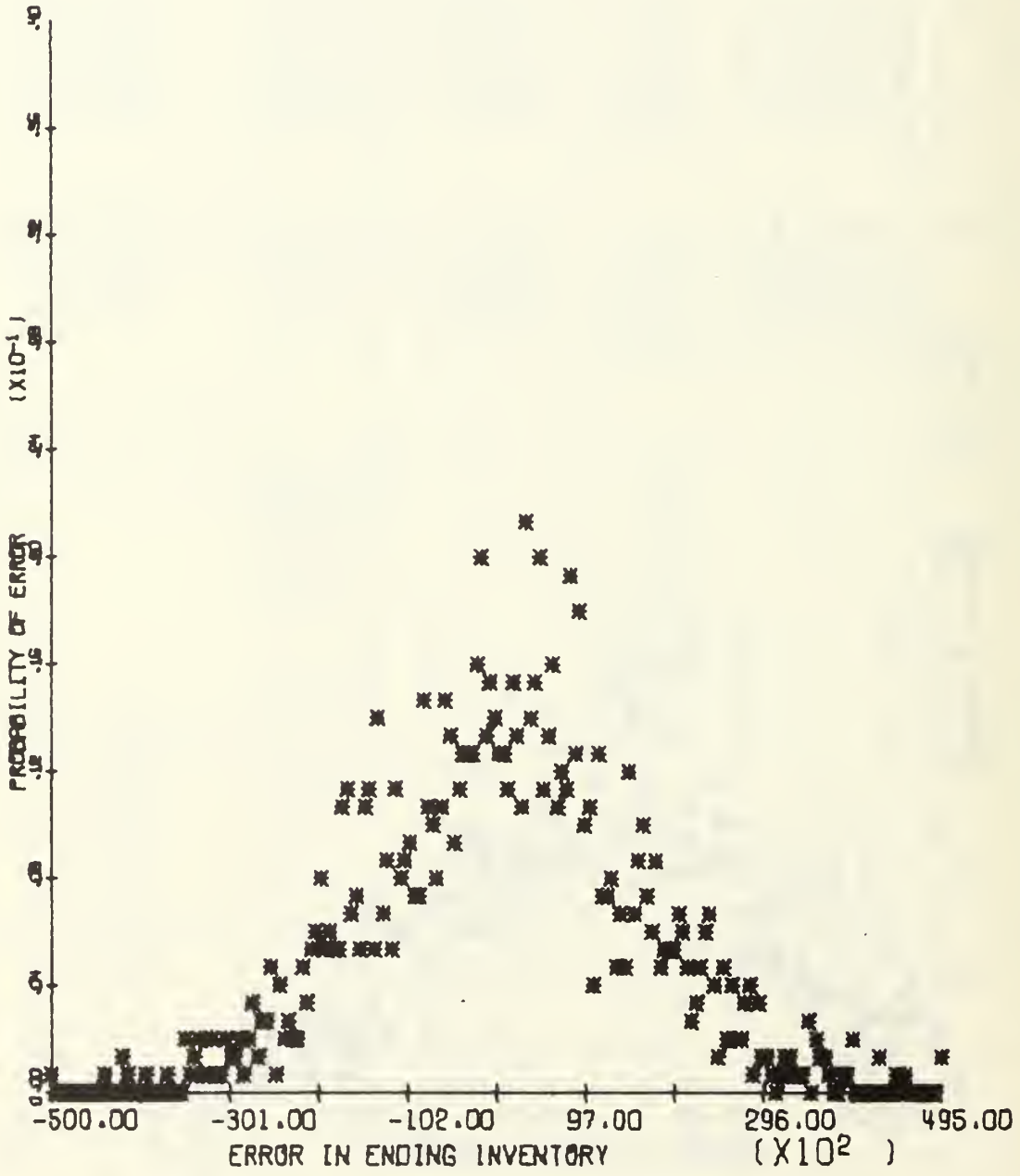


LEGEND

TOTAL BUSINESS ACTIVITY=9M0.
PLOTTED AFTER 1500 ITERATIONS
FREQUENCY INTERVALS OF 500

APPENDIX F

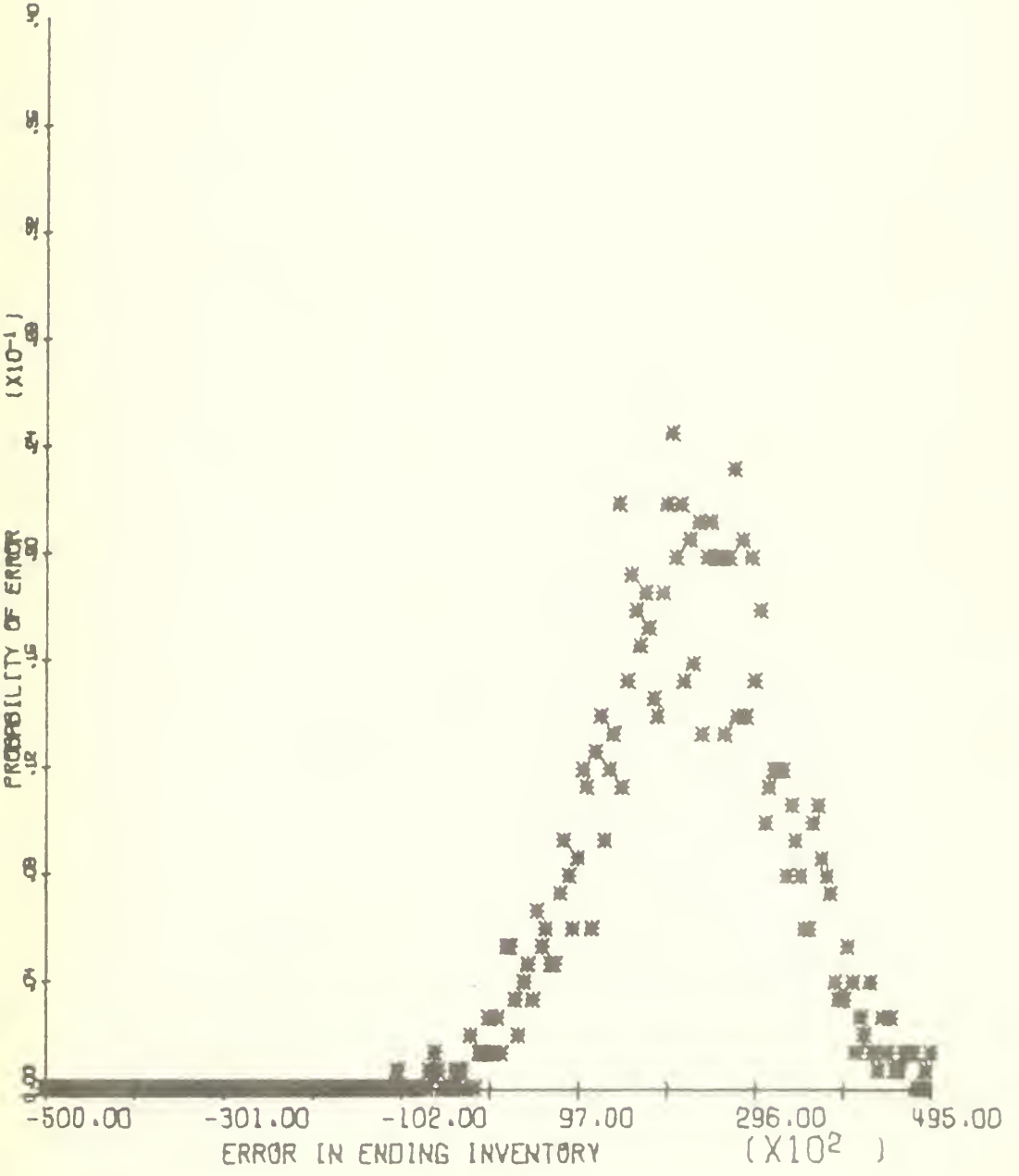
PLOT OF THE PROBABILITY DISTRIBUTION OF THE ERROR IN THE W.I.P. INVENTORY COMPUTED BY THE SYSTEM SIMULATION MODEL



LEGEND

TOTAL BUSINESS ACTIVITY=9M0.
PLOTTED AFTER 1500 ITERATIONS
FREQUENCY INTERVALS OF 500

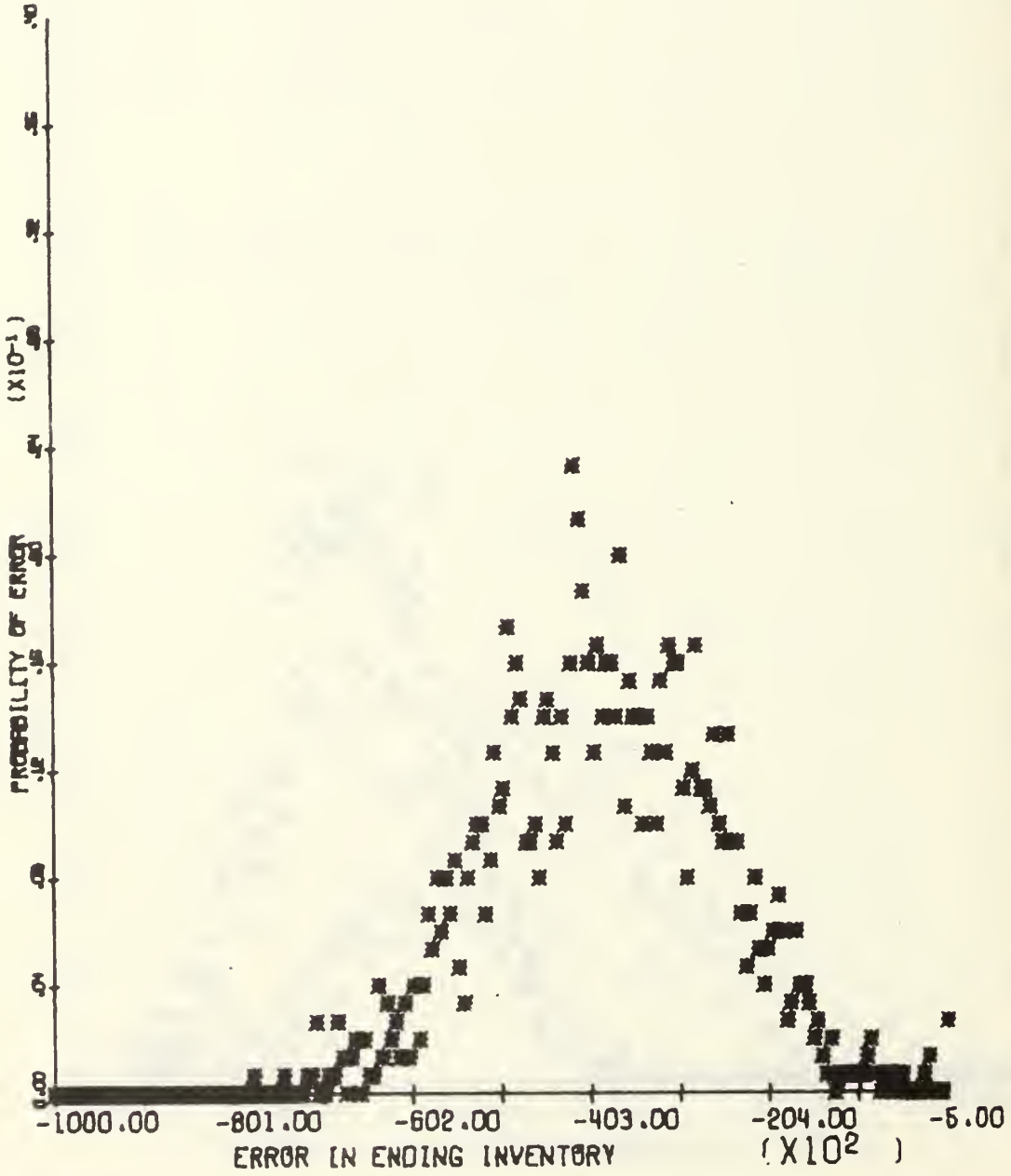
PLOT OF THE PROBABILITY DISTRIBUTION OF THE ERROR IN FINISHED GOODS INVENTORY COMPUTED BY THE SYSTEM SIMULATION MODEL



LEGEND
TOTAL BUSINESS ACTIVITY=9M0.
PLOTTED AFTER 1500 ITERATIONS
FREQUENCY INTERVALS OF 500

APPENDIX H

PLOT OF THE PROBABILITY DISTRIBUTION OF THE ERROR IN THE COMBINED INVENTORY COMPUTED BY THE SYSTEM SIMULATION MODEL



LEGEND
TOTAL BUSINESS ACTIVITY=9MO.
PLOTTED AFTER 1500 ITERATIONS
FREQUENCY INTERVALS OF 500

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7. AUTHOR(s) David C. Burns		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Postgraduate School Monterey, California 93940		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
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Audit

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

During fiscal year 1972, the writer developed an auditing case which is currently used in the course MN 4151 (Internal Control and Auditing) at the Naval Postgraduate School. This case involves complex auditing and internal control problems related to manufacturing inventories and it is based upon a computer simulation model. The case has been well received by NPS students and appears to be a very effective teaching tool.

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20. ABSTRACT (Continued)

A teaching approach for using this simulation case is described in an article entitled "A Computer Simulation Approach for Teaching the Evaluation of Internal Control." This article is scheduled for publication by the American Accounting Association early in 1974 in the Association's forthcoming book, tentatively entitled Accounting Education.

This report contains copies of all of the material which is necessary to implement the teaching approach described in the article mentioned above. The purpose of this report is to make the simulation case available to auditing instructors at universities other than the Naval Postgraduate School.